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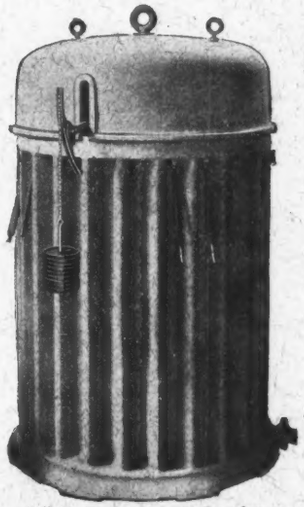

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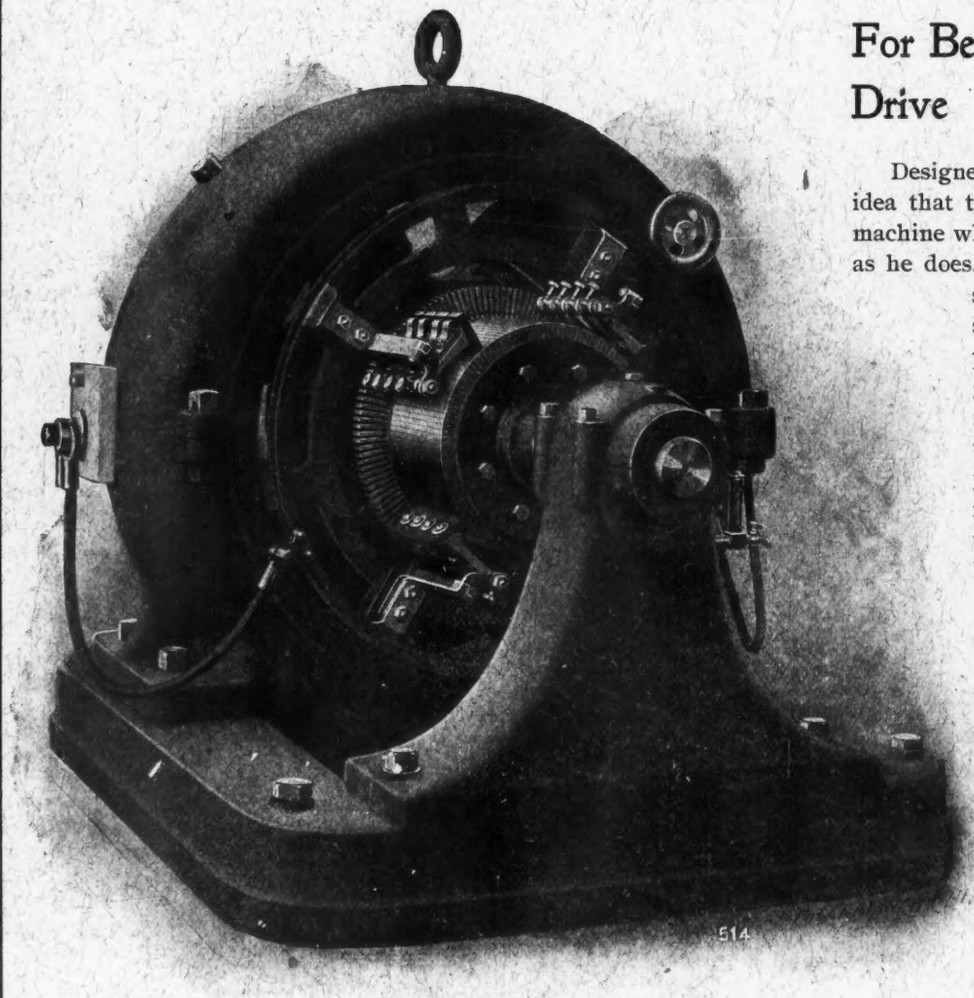

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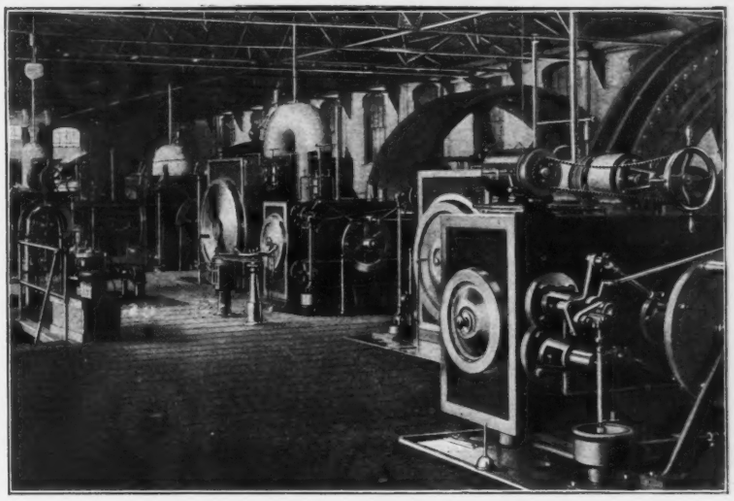

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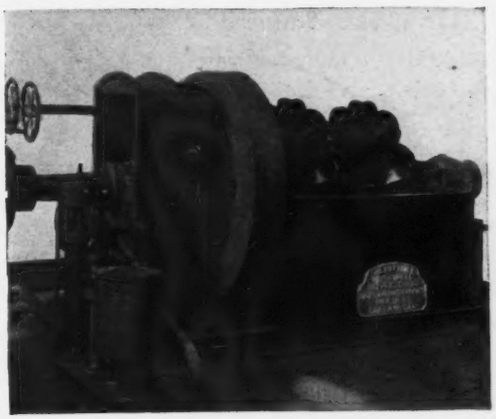

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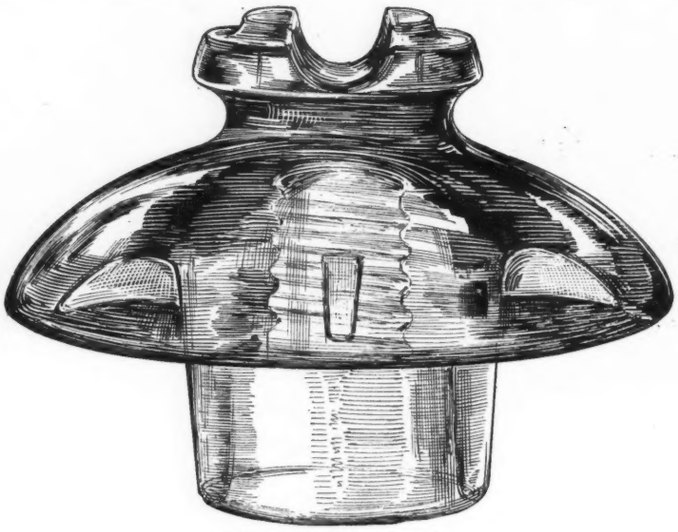

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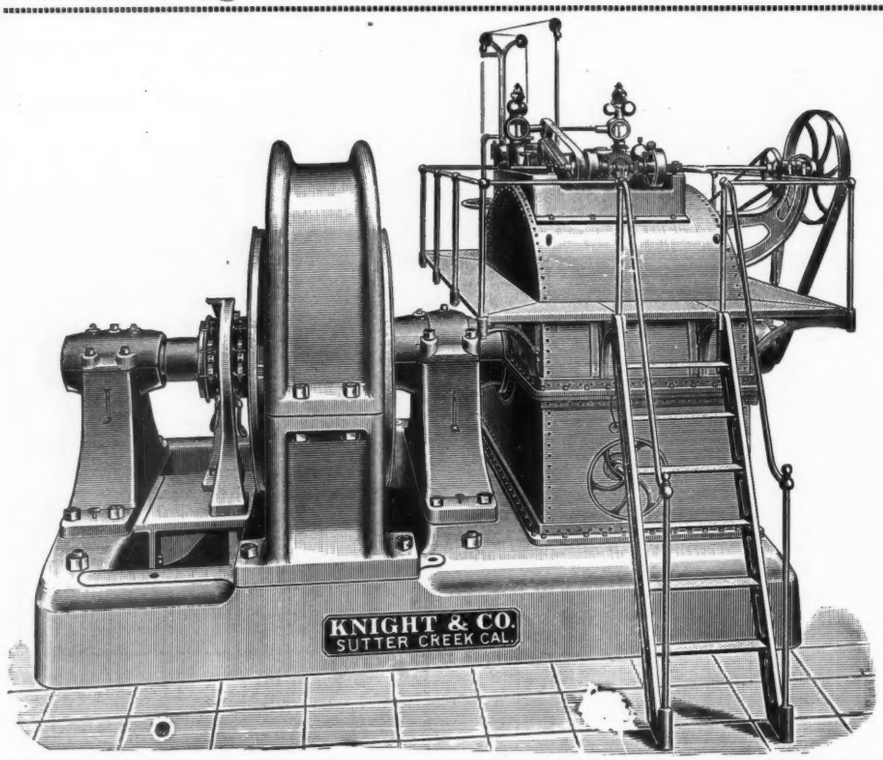

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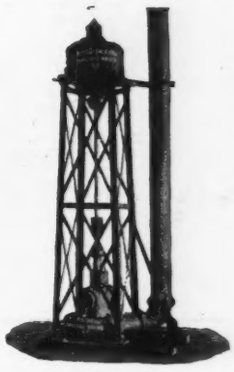

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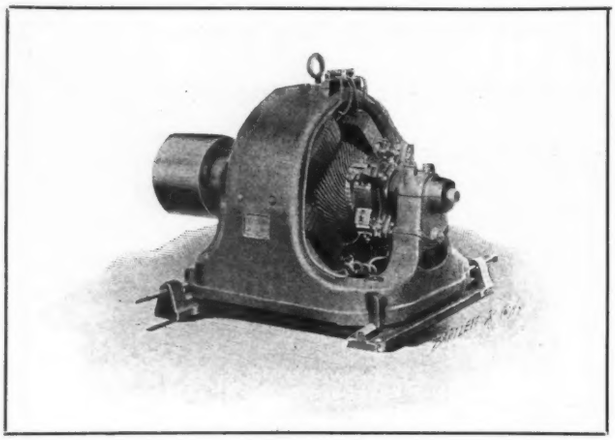

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VOLUME XII. SAN FRANCISCO, JULY, 1902. NUMBER 7

*Wanted: An Equation of Success.**

BY DR. CHARLES VAN NORDEN.

GENTLEMEN: You are gathered here today to represent and further a great cause.

You belong to a class of men, who by their energy, skill and courage are revolutionizing the methods of industry. Some of you are engineers, the sappers who assault an old citadel of ignorance, and some of you are sponsors of corporations, which by their mighty and far reaching construction annihilate distance, equalize the natural resources of localities for the welfare of immense areas, bring light into the dingy homes of the poor and shed brilliant splendor upon luxury. All of you face the future.

DR. CHARLES W VAN NORDEN.

It is with emotion I stand here, your presiding officer, calling to mind how more than twenty years ago, addressing a convention at Highgate Falls, Vermont, to illustrate a theme, I predicted that in a few years the cataract, whose roar was audible in our place of assemblage, would in time furnish light and power to neighboring villages, none nearer than nine miles. They smiled incredulously and deemed me an enthusiast, romancing; and long since my prophecy became fact. Little thought I then that I should myself become engaged in the beneficent work of long distance transmission—a prophet realizing his own foreshadowings.

We are not, strictly speaking, a scientific body, and yet we are engaged in the application of newest and abstruse science. We follow after the scientists and yet we also go before them. We are their heirs, and also their ancestors, furnishing them with queries of great moment, making hints of much value and applying their consequent generalizations.

Several problems of vast interest to us today appeal to our intelligence.

First of all, the problem of promotion and finance. A teacher once asked a class of young boys what was the most difficult thing to acquire in bicycling. A chorus of yells responded, "The bicycle, sir." And if you should ask me for the most difficult thing to acquire in long distance transmission I should say, "The cash, sir." Dark and devious is the pathway of some promotors, and long and weary will likely prove the journey for all; but by hook or by crook the gold must be raised—and tons of it.

The cash secured, the commercial problem looms up, menacingly. How can we make our investment profitable, for profits, after all, are our objective? Thus, granted a field of business, provided our kilowatts can be delivered at a tempting price, with gas, coal, oil, etc., as competitors already in possession, how far back into the mountains may we go to secure water power, itself so cheaply developed that, allowing for so much money in investment, so much annual depreciation, so much waste of generated horsepower in transition, and so much running expense, the current can still be furnished in requisite quantities and at price to sell. It is evident that there must be a limit to the permissible distance.

Theoretically, we could bring to San Francisco energy from Columbia, or even Niagara Falls; but this would not pay. By what equation shall we determine the permissible distance of source of power from business center. This is a most important and, as well, a most fascinating inquiry. Where is the mathematician who will reduce the solution to a neat formula? It is easy to declare that kilowatts should cost the company only so much at the

*Presidential address delivered before the Sixth Annual Convention of the Pacific Coast Electric Transmission Association, San Francisco, June 17-18, 1902.

power house in order to cost the consumer so much at the place of delivery; it is a very different matter to figure out the individual factors in the equation. Look a moment at these factors.

Thus the business field—how important that it should be described accurately in your figuring as so many thousand horsepower. How much power for motors and lighting does the field now consume, and how much more can it be tempted by lower rates and probable civic growth to absorb? It is easy for enthusiasm—the wish fathering the thought—to overestimate this item. But to underrate very much will prove fatal.

Then the competition of coal, oil, gas, etc.—are the parties dealing in these commodities able to reduce their rates to meet our attack without self-annihilation? Moreover, what competition of enterprise like our own will the situation likely arouse? The more inviting it is to us, the more inviting it will be to others. Will other long transmission giants, big and insolent as ourselves, strive to reach the narrow gateway to success first and to crowd us out and trample us down? Must we fight with our brethren for the heritage?

Again, on what terms have we secured our capital, with what discount on our bonds, with what rates of interest, and with what fateful total of final principal some day to be paid in full? The cost of the plant is not the money paid out for labor and material, that is, the actual payment, but the par value of our indebtedness incurred.

Another factor of immense importance in our commercial equation is the depreciation of power house apparatus, pole lines, raising and lowering transformers and distributing plant. The moment construction is finished many forces begin to destroy the result—chemical disintegration, oxydizing metals, vitiating the insulating qualities of rubber, etc.—biological assault of fungus, microbe and worm—fire rain, flood, tempest, etc. The moment a man is born he begins to die, and nature in organizing her forms provides for their sacrifice to other forms, seemingly with purpose, if there be any purpose, to secure only evolution itself as final result. All human construction responds to the same law, and only awaits its doom from the hour of its first beginnings. What percentage on our cost of plant must we annually count off for lost? The transformer has a very brief life, the generators now made, a very long one; but sooner or later both will lie on the junk heap. Any financier or promotor who allows less than 5 per cent. on actual, that is, payment, cost, for depreciation, will have a future sorry awakening. It will average more than 5 per cent. annually, in all probability; and ascertainment of the exact percentage is quite essential to a reducible equation of any value. No doubt this factor of depreciation is the most formidable and the most elusive. Few corporations are willing to invest a great sum of money and then calmly charge against themselves, on account of wear and tear, 5 to 10 per cent. of the entire payment; and few promotors will ever be heard alluding to so disagreeable an aspect of the financial problem. Both corporation and promotor say: "Oh, let the future look out for that." And all will go well, while all is new; and when the flumes are found rotten, pipe lines bursting, insulation reduced to powder, transformers burning by the score, poles falling and water wheels antiquated, a new issue of bonds will add to the burden of the manager and threaten future solvency.

Two Irishmen tried to kill a rattlesnake, and one of them declared the creature dead. "The baste is dead intoirely." "But no, Mike," protested the other, "sure and he moves." "Be jabers," insisted the first, "the baste is dead intoirely, only he is not conscious of it." There are some electric companies that are dead entirely, only they are not conscious of it; some of these fine mornings they will wake up to this fact.

The losses of energy by various resistances and counter strains in the different parts of the system are easily calculated and need only mention; they must be in the equation, but present no difficulty in calculation.

The running expenses also can be figured with considerable exactness, in view of accumulating experience.

The risk from labor troubles is not the least of the factors in our equation. Unless we can by close combination throttle this evil, we must figure largely on its bearing unfavorably upon success.

Allied to this growing menace of organized labor is the seething of the communistic tendencies of the times. Very many, jealous of capital, hostile to the ownership of franchises by private parties and indulging in visionary expectations of socialistic action on the part of the people, favor the assumption by communities of all enterprises of a public nature. Foremost among the schemes urged is that of municipal ownership of public utilities. This we need not fear, not only because manifold experience is demonstrating the inefficiency, extravagance and corruption actually attending such experiments; but also because, if they should be very generally tried, they would not menace long transmission, since municipalities need our cheap power, whether they or we peddle it out to customers. For us a far more dangerous agitation is that which now proposes state expropriation of all water rights, reservoirs and reservoir sites, and all systems of distribution of water, in the interest of complete state control of irrigation and of the sale of power derived from water. This scheme openly advocates condemnation of both water properties and wheat ranches on a method of valuation which makes the appropriation little less than sheer confiscation. Indeed this movement is simply an organization of public robbery on a large scale, is characterized by all the insolence of the communistic spirit, and is the more dangerous because its involved perils to all ownership of private property is not perceived by its adherents, and all its fallacies have not been shown up by experience. If successful this agitation will result in the confiscation of every long transmission source of power. It does not, however, seem to be making very rapid progress; and whether, in a state where political life is so corrupt as in California, the people will tax themselves to raise millions to purchase old reservoir systems and to construct new ones, placing enormous sums of money at

the disposal of their frail representatives, with danger of peculation, inefficient expenditure and only remote benefits; and whether the ranchers to be thus encouraged will prefer to their present "water lords," as we are called, their own county politicians, remains to be seen. For one, I doubt it; but the agitation is being vigorously pushed in the name of progress. We need to exercise vigilance and to be prepared to combine our forces for Boer-like tenacity of defense.

There are thus, in our equation of success, factors of cost, factors of loss and factors of risk, with a constant for depreciation; and none of these should be omitted from the calculation of investor in long transmission industries.

Leaving the commercial aspect of our work and its fascinating equation of success, we can profitably spend some of our time upon legal involvments. How can we best provide against the possible assessing of damages for accidental personal injuries by proper warnings, how defeat the meddling of the fool and the malice of the knave, how prevent the stealing of current, the abuse of flat rates, the blackmailing of pettifogging lawyers, etc., by securing new legislation, by judicially applying old statutes, by appeals to higher courts? At the last session of the State Legislature the Standard Company, by a little judicious lobbying, secured an enactment making it a penal offense to mischieviously or maliciously tamper with or injure transmission apparatus; and your presiding officer, with the generous help of Senator Robert T. Devlin, of Sacramento, succeeded in securing a statute making it a misdemeanor to steal current by tapping wires or meddling with meters. These were reasonable laws and were obtained without corruption. So long as we ask only for what is just there is a fair probability of securing the needed legislation, if not immediately, yet by exercise of a little patience and persistency.

There is also an ethical aspect to our work—yes, even if corporations have no souls. Our high tension currents are very marvelous and pleasing to contemplate—from a distance. "Doctor," asked an inebriate, when his physician was warning him, "Doctor, you don't think that stimulants are really going to hurt me, now, do you?." "Oh, no," replied the sage, "not if you leave them alone." Our wires are perfectly harmless—if you leave them alone. A large number of persons, not all employees by any means, have, during the past year, suffered injury or died from shock; and the result has been not only a general feeling of dread, or even of hostility to our work, embarassing the securing of rights of way and menacing by damages our incomes, but also an appeal to those feelings of humanity in ourselves, which even electricians share with their kind. How to lessen the danger, how to devise new and better methods of resuscitation, etc.—all such questions we should patiently entertain and strive to answer.

These are the practical problems. There are theoretical ones, bearing only indirectly upon the financial result. How to improve the transformer, how to get higher percentage of efficiency out of the motor, how to lessen a little the losses in our almost perfect generators, details in line construction involving betterment, insulation of more staying power, the relation of static strains to break down of insulation, minor discoveries of our men, recent discoveries of investigators in other parts of the world, hints as to sale of current, collection and management, wireless telegraphy and telephony and how to use them for communication with the distant power house—a thousand and one interesting items in this fascinating field of human effort.

Such, gentlemen, briefly outlined, are the themes for us to discuss. No one of us has a right to any secrets. What he learns is for all the others.

The papers to come before us at this session are highly instructive, and I bespeak for them hearty discussion.

We are entering a new field of human effort, with puzzles, perils and distresses all its own, and we face a very grand future, the involvements of which no one of us can wholly divine. We are pioneers, promotors of the novel, architects of the framework of industries to come.

Let us not belittle our work, and rather magnify the value of enterprise in our own field. Let us crown with the olive wreath of our praise courage and grandeur of design; but also let us make sure that our growing knowledge is, so far as it goes, accurate and our commercial schemes justified by the situation, and hence honorable to ourselves and honest to those on whose funds we draw.

LAND AND WATER VALUES IN CALIFORNIA.

THE State of California is particularly alive to the value latent in its running streams. This is largely due to the object lesson presented in the remarkable increase in land values and productive capacity of sections where the water supply has been intelligently utilized. Several thousand dollars were raised by private subscription for a thorough investigation of the supply to be obtained from certain watersheds in the state, and the subscribing organizations made application to the hydrographic branch of the United States Geological Survey for careful measurements of flow and other investigations relative to the existing conditions of forestry and topography upon three typical watersheds. As a result of these studies, conducted by J. B. Lippincott, hydrographer of the Geological Survey in California, it was found possible to obtain an annual output of nearly 650,000 acre-feet of water, or enough to cover annually an area of that extent to a depth of one foot, the estimated cost of installed capacity being about $8.00 per acre-foot. The water would be obtained from storage reservoirs and from pumping plants to be operated electrically by power generated by the neighboring streams.

It is believed that the addition to the resources of the state of this amount of water for irrigation purposes would be sufficient to support an additional 100,000 people, and would add in farm values fully $20,000,000 to the taxable property of the state, irrespective of the increase in town and city property which would of necessity follow.

The Illinois Glass Company has recently purchased an extensive electrical equipment from the Westinghouse Electric & Mfg. Co. This apparatus will be used for the operation of the machine, blacksmith and mould shops, blowers, etc., and includes a 250 kilowatt, two-phase, 440 volt, 60 cycle belted generator, twenty "Type C" induction motors, thirty-eight "Type O. D." transformers, and arc and incandescent lamps.

THE ECONOMY OF ELECTRIC POWER IN QUARTZ* MINING.

BY C. O. POOLE.

THE subject matter of this paper has been largely obtained from the practice of the mines on the Mother Lode in Amador and Calaveras counties, California. This paper is not intended as a scientific treatise of the subject, but its object is to present in a practical way the economical results obtained by the use of electric power in comparison with steam power, using wood, coal and oil as fuel.

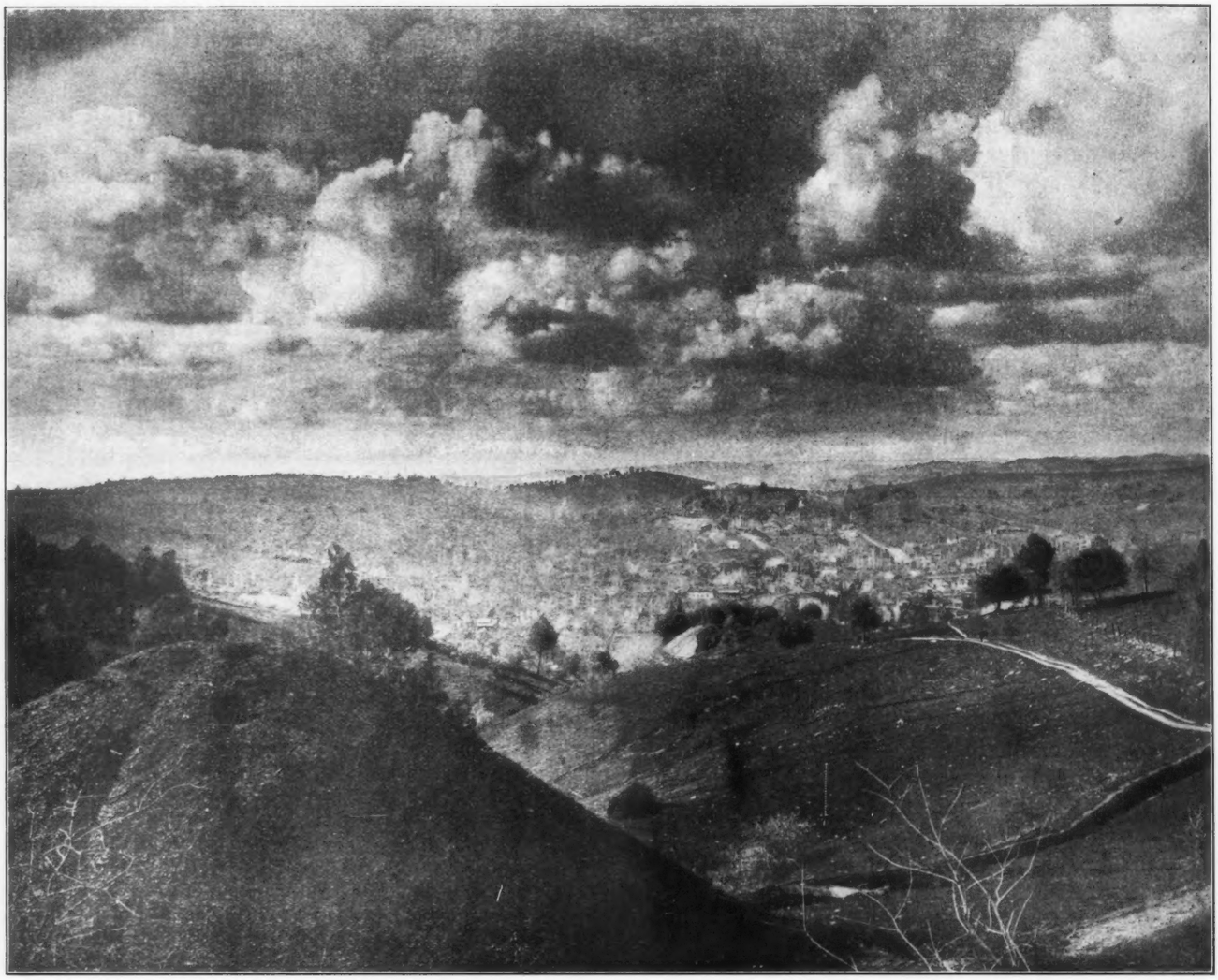


FIGURE 1. THE TOWN OF SUTTER CREEK NESTS AMONG HILLS OF THE MOTHER LODE IN AMADOR COUNTY, CAL.

For more than fifty years the monotonous rumble of the stamp mills has echoed and re-echoed among the hills in the vicinity of Amador and Sutter Creek, and they seem destined to rumble for another fifty years, thus completing a century of echoes and prosperity throughout the community. Recent developments have demonstrated that almost inexhaustible bodies of ore lie far below the surface of the ground. Old mines that were thought to have been worked out, and were abandoned and left idle for a quarter of a century, have within the past few years been reopened, and their owners, by sinking deeper into the ground, were rewarded by striking large bodies of pay ore that insure a profitable return for many years to come.

The ore encountered in this locality is of low grade, ranging from $2.50 to $6.00 per ton; hence, in order to work a mine profitably under these conditions, it must be well managed. The mine superintendent must be a very versatile man; he must have good business judgment, and he must be scientific, mechanical, practical and economical. You must not be surprised, then, upon approaching him with a proposition to equip his mine with electric power, if your stereotyped arguments are received with a kind but pitying smile, and you in turn receive a very valuable lecture on power for mines. If, however, you are able to convince him that your proposition has merit, and a saving in cost of operation can be effected by its adoption, he will enter into the scheme with you, and better treatment than you will receive at his hands could not be asked for. Until quite recently the source of power at these mines has been steam and water power. The water wheels are working under heads varying from 160

*A paper presented to the Sixth Annual Convention of the Pacific Coast Electric Transmission Association, June 17-18, 1902.

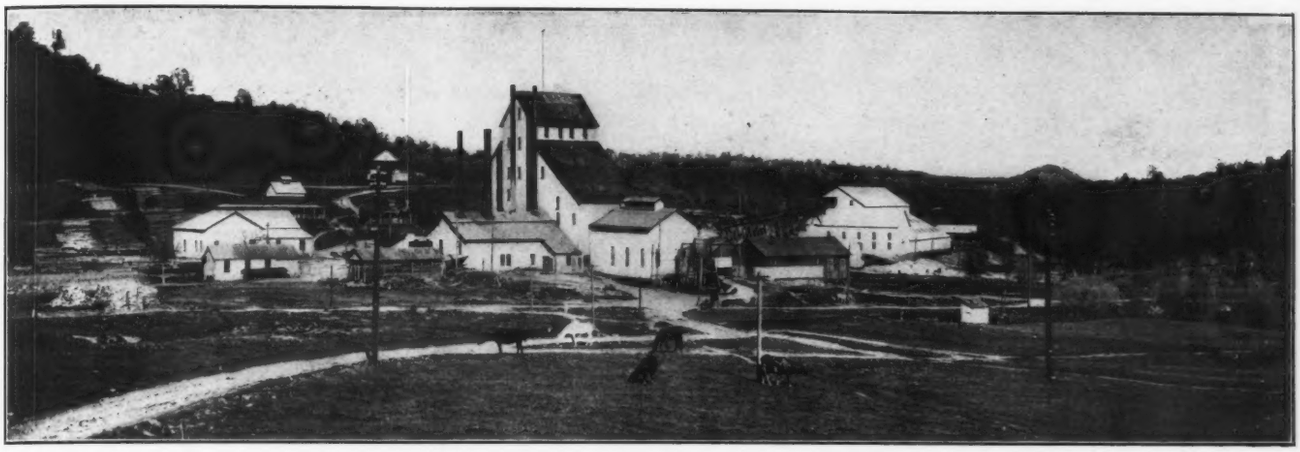


FIGURE 2. A GENERAL VIEW OF THE ONEIDA MINE IN AMADOR COUNTY.

feet to 520 feet. Water power under the last named head, at the prices now charged there, is about equivalent in cost to electric power at $6.50 per horsepower per month. On heads lower than this, however, it is obvious that material savings can be made, hence, water wheels in this locality are rapidly becoming a thing of the past.

The uses of power at a mine are somewhat varied, and in applying electric power, each case is a study by itself. The principal uses consist in driving stamps, concentrators, air compressors, sawmills, blowers, pumps and hoists. It is the hoist that I wish particularly to dwell upon. The conclusions that I draw in this connection may differ widely from the ideas of many, but I am, nevertheless, firm in my convictions.

The fuel used for steaming purposes is principally wood and fuel oil. coal has been used, but not to any great extent. The competitors to electric power are, therefore, wood and oil. If there is one mistake that a mine superintendent makes, it is in estimating the amount of power that he is using. He invariably over-estimates the actual horsepower consumed and owing to the intermittent character of the work (except that of the mill), it is very difficult to accurately estimate the power developed by a steam engine used in mining duty. If, then, you are told that he is making a horsepower for $8.00 or $10.00 per month with wood, don't be discouraged, for in obtaining these figures he may have divided his fuel bill by the rating of a 100 horsepower engine, when the average power developed was less than fifty horsepower.

In order to demonstrate what can be done with steam power, let us enter into a few figures:

WOOD.

A cord of dry pine wood (which is the variety of wood used in this section), weighs approximately 2000 pounds, and its contents measure 128 cubic feet, of which, about 56 per cent. is in wood and 44 per cent. is in spaces.

The composition of average air-dried wood, which

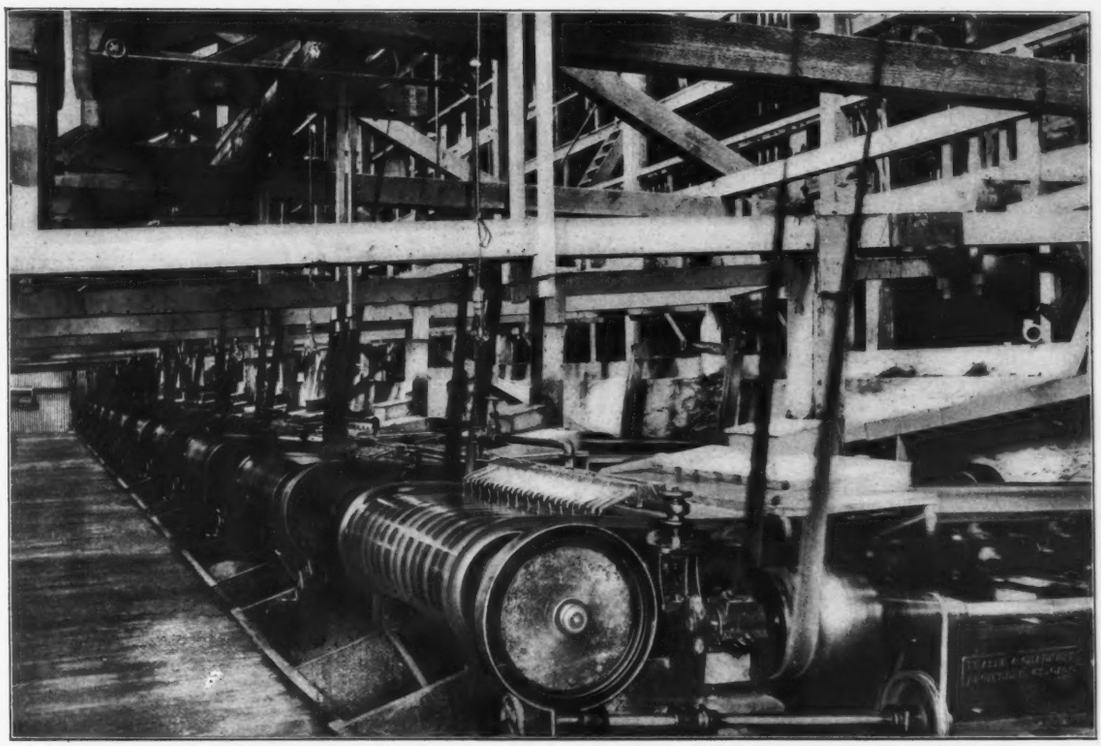


FIGURE 3. THE ONEIDA CONCENTRATORS ARE DRIVEN BY A 30 HORSEPOWER INDUCTION MOTOR.

FIGURE 4. THE 60-STAMP MILL AT THE ONEIDA MINE IS DRIVEN BY A 150 HORSEPOWER INDUCTION MOTOR.

carries 5,000 British thermal units (B. T. U.) per pound, is as follows:

Carbon	37.50	per cent
Hydrogen	4.50	"
Oxygen	30.75	"
Nitrogen	.75	"
Ash	1.50	"
Hygrometric water	25.00	"
	100.00	per cent

Given the heat units in a pound of wood and the pounds of wood per cord, let us now proceed to demonstrate the cost of steam power with wood for fuel.

A pound of saturated steam at 90 pounds gauge pressure contains 1215 heat units. If the feed water, after passing through an exhaust heater, has a temperature of 150° F., then the actual heat units absorbed by each pound of water evaporated, will be 1215—150=1065 British thermal units. The theoretical evaporation of a pound of wood under these conditions will be $\frac{5000}{1065} = 4.69$ pounds, which are the heat units contained in a pound of wood, divided by the heat units required to evaporate a pound of water.

Assuming a boiler efficiency of 65 per cent. (which is as good as can be expected when working under variable loads), the actual evaporation under working conditions will be: $4.69 \times .65 = 3.048$ pounds of steam per pound of wood; a cord of wood then weighing 2000 pounds will evaporate $3.048 \times 2000 = 6096$ pounds of water into steam at 90 pounds gage pressure.

The ordinary simple non-condensing steam engine will consume 30 pounds of steam per horsepower hour, working on unsteady loads. If, then, we divide the total pounds of water evaporated by a cord of wood into the pounds of steam consumed per horsepower hour by the engine, we get $\frac{6096}{30} = 203$ horsepower hours.

Taking the cost of wood at $5.00 per cord, the cost per horsepower hour will be $\frac{\$5.00}{203} = \$0.0247$. As there are 720 hours in a thirty-day month, the cost per horsepower per month will be $\$0.0247 \times 720 = \$17.78$. While it is possible to do somewhat better than this with a plant working under favorable conditions, it will be found in general mining practice that the price is rather above this figure than below it.

Through the kindness of Mr. J. C. Kemp Van Ee, of the Royal Consolidated Mine, Calaveras County, I am able to present the results of an efficiency test of a steam plant working under almost ideal conditions. The plant

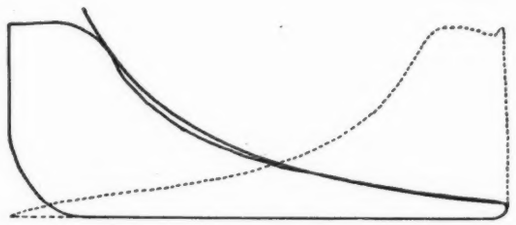


FIGURE 5. TEST OF ENGINE AT ROYAL MINE, CALAVERAS COUNTY, CAL., APRIL, 1902.

Type of engine	Atlas Corliss	
Diameter of cylinder	14.5	inches
Stroke of piston	36	"
Revolutions per minute	90	
Boiler pressure	100	pounds
Terminal pressure	23	"
Mean effective pressure	34.161	"
Horse power	90	
Steam consumed per horsepower hour	23.06	"

in question is driving a 40-stamp mill, consisting of 20 stamps weighing 1050 pounds each, and 20 stamps weighing 800 pounds each, all with a drop of 5½ inches, making 110 drops per minute. The mill contains 12 concentrators in addition to the mill equipment, and the

engine drives a 7-kilowatt generator for supplying lights for the mill and houses. The results of this test follow:

EVAPORATION TEST OF SECOND GROWTH PINE WOOD.

Type of boiler	Horizontal tubular.
Size of boiler	66 inches diameter by 16 feet long.
Number of tubes	98 three-inch tubes.
Heating surface of shell	= 132 square feet.
Heating surface of tubes	= 1230 square feet.
Total heating surface	= 1362 square feet.
Grate surface	25 square feet.
Ratio of heating surface to grate surface	= 54.5 to 1.
Duration of test	10 hours.
Amount of wood burned	= 2⅝ cords.
Weight of wood burned	= 9331 pounds.
Weight of wood per cord	= 3554 pounds.
Total water evaporated	= 25,124 pounds.
Temperature of feed water	60 8° F.
Steam pressure, average gage	101 4 pounds.
Water evaporated per pound of wood, actual conditions	= 2.693 pounds.
Water evaporated per pound of wood from and at 212°	= 3.224 pounds.
Quality of steam	Practically dry.

While the test shows an evaporation of 3.224 pounds of water per pound of wood, the results actually obtained in practice are about 12 per cent. better than this, as the feed water is heated by the exhaust steam from the engine and enters the boiler at 198° F. Owing to the difficulty of arranging the weighing device for handling the feed water after passing through the heater, we were forced to use cold water, cutting the heater out of service. Adding this 12 per cent., the evaporation is 3.61 pounds of water per pound of wood.

The heat units imparted to the water were $1117 \times 25,124 = 28,063,508$. Assuming an efficiency of 70 per cent. for the boiler, the total heat units given out by the wood was $\frac{28,063,508}{70} = 40,090,725$ and the heat units per pound of wood amount to $\frac{40,090,725}{9331} = 4296$, which is about right for that class of wood.

The power cost for running this mill with wood at $4.25 per cord, is as follows:

Fuel cost per horsepower hour,	$0.0103
Labor " " " "	0.0023
	$0.0126

Making the cost per horsepower per month to amount to $9.07.

The results obtained from this plant are surprisingly good, but it must be borne in mind that it is a very efficient plant, which is working under the most favorable conditions. The boiler and engine are properly proportioned for the duty, the load is constant, the engine cuts off at the proper point to obtain the best results from the expansion of the steam, and the feed water is heated to a remarkable degree. I think it will be acknowledged that a plant operating under the fluctuating conditions of the average mining load, such as hoists, air compressors, pumps, rock crushers, sawmills, etc., that the consumption of steam per horsepower hour will reach from 30 to 35 pounds instead of 23, as shown by the test data above, and the efficiency of the boiler will be below 70 per cent.

COAL. A good quality of steam coal yields 13,000 British thermal units by oxygen calorimeter, the approximate analysis being as follows:

Moisture	3.50 per cent
Volatile combustible matter	34.27 "
Fixed carbon	54.23 "
Ash and waste	8.00 "
	100.00 per cent

This quality of coal can be landed at the mines for about $13.00 per ton of 2240 pounds. Under the same conditions upon which wood was figured, the cost of power using coal for fuel will be approximately as follows:

Theoretical evaporation = 12.2 pounds of water per pound of coal.

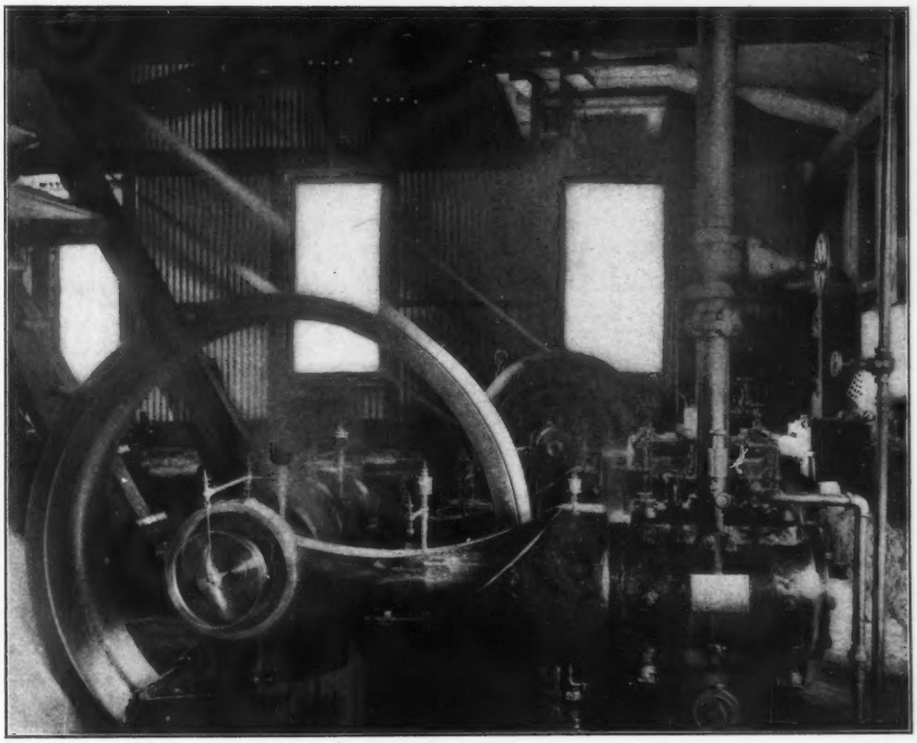


FIGURE 6. IN THE ONEIDA MINE A 150 HORSEPOWER SYNCHRONOUS MOTOR DRIVES AN AIR COMPRESSOR.

Actual evaporation under working conditions = 7.93 pounds of water per pound of coal, which = 17,763 pounds of steam per ton of coal.

Horsepower hours per ton of coal = 592; cost per horsepower hour = $0.022; cost per horsepower per month = $15.84.

While this cost appears somewhat less than wood, yet for general mining work wood has many advantages over coal.

FUEL OIL

We now come to the real competitor of electric power in California—wood and coal having fallen an easy prey—but oil offers a more stubborn resistance, especially in the valleys or at tide water where it can be landed to the customer at a price of 67 cents a barrel. In the mining districts, however, where the transportation rates are high and oil costs $1.50 per barrel, it is not such a formidable foe. It is well, however, for the transmission people to keep informed on the oil situation, for oil has come to stay in California.

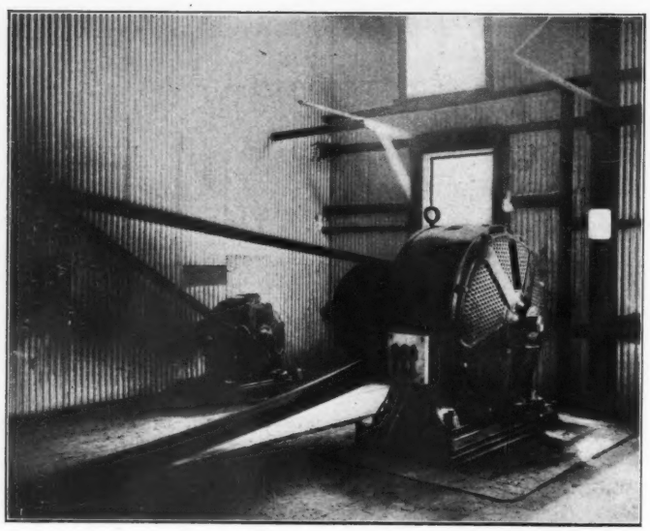


FIGURE 7. THE MOTORS THAT DRIVE THE ONEIDA MILL

Within the past few years, the oil developments in this state have been phenomenal, and the hundreds of thousands of acres of oil lands which are already prospected and developed, insure a supply for many years to come. The oil sands in the Kern River and Bakersfield districts range in thickness from a few feet to five hundred feet, and they contain from 30 per cent. to 40 per cent. of oil. Of course, all of this cannot be extracted by the ordinary methods of pumping, but it is safe to say that 10 per cent. of the bulk of good oil sand is extractable.

Still more remarkable is the recent development of the Beaumont, Texas, oil fields. Up to the first of this year, 130 gushers had been developed, none of them having a capacity of less than 4,000 barrels per day, and fully 100 of them have a capacity of from 20,000 to 100,000 barrels per day. If the wells were permitted to flow uninterruptedly the daily output would be 2,500,000 barrels, which is the equivalant of about 622,000 tons of coal, or enough fuel to supply the needs of San Francisco for a year; but luckily for the transmission companies, these wells are far enough away to cause them no uneasiness.

Here are some characteristics of various crude oils:

ANALYSIS OF BEAUMONT CRUDE.

Gravity	= 21° B.
Flash Point	= 142° C.
Burning Point	= 181° C.
Cold Test "	= —6° C.
Carbon	= 85.03 per cent
Hydrogen	= 12.30 "
Oxygen and Nitrogen	= .92 "
Sulphur	= 1.75 "
	100.00 per cent

British thermal units by oxygen calorimeter = 19,060.
5 per cent of steam required to vaporize in burners.

ANALYSIS OF VENTURA COUNTY CRUDE.

Gravity	= 23.5°B.
Carbon	= 84.0 per cent
Hydrogen	= 12.7 "
Nitrogen	= 1.7 "
Oxygen	= 1.2 "
Sulphur	= 0.4 "
	100.0 per cent

GRAVITY OF THE DIFFERENT CALIFORNIA OILS.

Central oil fields, Los Angeles	16° and 17° B.
Mackintosh Wells, Los Angeles	13° B.
Maltman Tract	14° B.
Summerland, Santa Barbara Co.	15° to 17° B.
Sunset Oil District, Kern Co	15° B.
Tar Creek	23° B.
Four Forks	22° B.
Kentuck	25° B.
Coalinga (Oil City)	34° B.
Puente Oil Wells	23° to 28° B.
Pacific Coast Oil Co., Pico Canyon	40° B.
Tuntas Creek, San Mateo Co	45° B.
Moody Gulch, Santa Clara Co	44° B.

GRAVITIES OF CRUDE OIL. BEAUME HYDROMETER, TEMPERATURE, 60° F.

	Specific Gravity	Weight per Bbl.	Barrels per Ton		Special Gravity	Weight per Bbl.	Barrels per Ton
15°	.9655	338	6.63	28°	.8860	310	7.24
16°	.9589	338	6.69	29°	.8805	308	7.28
17°	.9523	334	6.73	30°	.8750	306	7.32
18°	.9459	331	6.77	31°	.8695	304	7.37
19°	.9395	328	6.82	32°	.8641	302	7.42
20°	.9333	326	6.87	33°	.8588	300	7 47
21°	.9271	324	6.91	34°	.8536	299	7.52
22°	.9210	322	6 96	35°	.8484	297	7 56
23°	.9150	320	7.01	36°	.8433	296	7.60
24°	.9090	318	7.06	37°	.8383	294	7.65
25°	.9032	316	7.10	38°	.8333	292	7.70
26°	.8974	314	7.15	39°	.8284	290	7.75
27°	8917	312	7.19	40°	.8235	288	7.79

It will be seen from the table that the weight per barrel varies perceptibly with the gravity, and at first sight it may appear that the low gravity oil would be the cheaper to use, but in fact there is very little difference in the fuel value of a barrel of oil whether the gravity be 14° or 34°; for, while there are more pounds in a barrel of low gravity oil, there are less heat units per pound.

From an average of several samples that I have tested, 16° B. oil contains 18,000 British thermal units per pound, and 34° B. oil contains 22,200 British thermal units.

Coming back to the original subject, let us work out the cost of steam power with oil for fuel, under the same conditions that wood and coal were treated.

A barrel of 16° B. oil weighs (allowing for wastage), 330 pounds, delivered; heat units per pound = 18,000; theoretical evaporation = 16.9 pounds; actual evaporation—boiler efficiency at 65° = 10.98 pounds; pounds of water evaporated per barrel of oil = 3623; horsepower

hours per barrel of oil = 120.7; price per horsepower hour, oil at $1.50 per barrel = $0.0124; price per horsepower per month = $8.93.

This result can be obtained under the most favorable conditions, but it is safe to say that with ordinary mining practice, it will cost at least 30 per cent. more than this amount, for oil on a variable load is more difficult to handle economically than either wood or coal, and the losses are consequently far greater. The true cost per horsepower per month would then be fully $11.90.

Taking the cost of electric power at $6.50 per horsepower per month, the comparative costs for power will be as follows:

Wood.....	$17.78	Saving effected by electric power...	$11.28
Coal.....	15.84	" " " " ...	9.34
Fuel Oil.....	11.90	" " " " . .	5.40

The mine superintendent takes kindly to the electric motor for all purposes except for hoisting, and to my mind his exception is well taken, for until a simple, better and more reliable electrical hoist is developed, I will hesitate to recommend them to a customer. In my opinion, compressed air is going to be universally used for hoisting purposes, where cheap electric power is obtainable and when a compressor is required for other purposes in the mine. In the ordinary use of a compressor at a mine, it is not used to its rated capacity more than 40 per cent. of the time. If, then, receiver capacity be available to store the air at times of light demand upon the compressor by the drills, and thus enable the compressor to be operated at full load all the time, the motor and compressor would be run at their highest

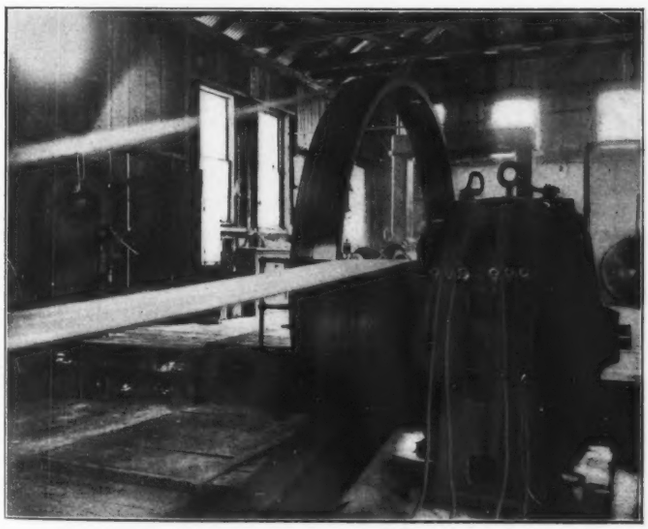


FIGURE 8. THIS 150 HORSEPOWER INDUCTION MOTOR DRIVES THE COMPRESSOR AT THE LIGHTNER MINE, ANGELS, CAL.

efficiency, and sufficient air could be stored to operate the hoist under ordinary conditions, and quite efficiently, too, by re-heating the air. It is not generally known that a pound of coal used for re-heating air will produce a horsepower hour, while it requires from four to five pounds of coal to give the same result with steam; but such is the case if the air be used in an engine fitted for the purpose.

But, for the sake of argument, let us suppose that we use the air without re-heating, and assume that air and steam are equal as far as expansive effects are concerned; then, if electric power costs $6.50 per horsepower per month, and the compressor has an efficiency of 60 per cent., the cost for air delivered to the engine will be $10.83

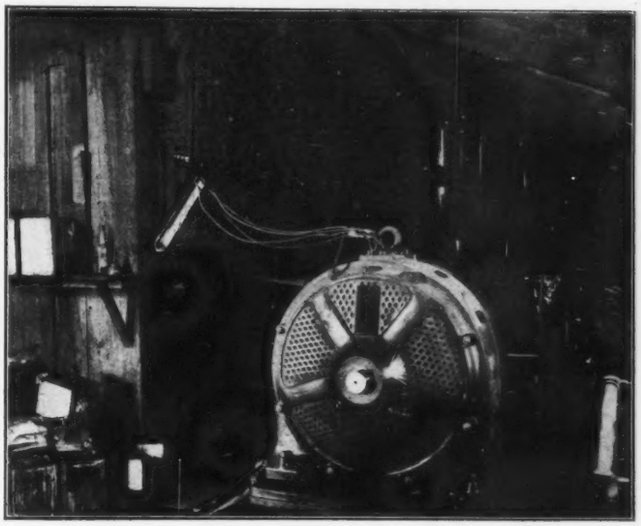


FIGURE 9. THE 100 HORSEPOWER INDUCTION MOTOR AT THE LIGHTNER MINE.

as against oil at $11.90, and by using a small amount of fuel for re-heating, these results can be far exceeded.

At the Lightner Mine, Calaveras County, electric power has been used exclusively for several years. A 150-horsepower motor drives a two-stage compressor 13 inches by 21 inches by 22 inches stroke, and running at seventy-five revolutions per minute. The sawmill, a pump and a blower are also driven by the same motor. The relief pipe from the air receivers is connected to the steam boilers, two of which act as additional receivers, and another one of them being used as a re-heater. About one cord of wood is burned per day in re-heating. There is operated a 60-stamp mill, which is driven by a 100-horsepower induction motor; a 20-horsepower motor drives the rock crusher, and a 5-horsepower motor is used for operating a telpherage system for carrying sulpherets to the chlorination works. All the hoisting is done with compressed air, as is also the lifting of all the water, which is taken from the 600-foot level. In addition to this work, seven 3¼-inch drills are supplied with air from the same compressor. The total power bill for January, 1902, was $1457.50, including the cost of the wood used for re-heating purposes, which makes the power cost per ton of ore milled to be 21 cents, including all power charges.

Through the kindness of Mr. J. B. Tregloan, of the South Spring Hill Mine, near Amador City, I am permitted to present some data on results obtained at his plant, and which were published in *The Mining and Scientific Press*, for April 20, 1902. This publication gives the results actually obtained at this mine, as follows:

The South Spring Hill Mine is using a 10x18-inch duplex, single stage, belt driven compressor, the area of the outlet ports being nine inches square on each end of each cylinder, the port

area being reduced to six and one-quarter square inches, where it enters the main pipe, which is a disadvantage, but which, in this particular compressor, is unavoidable. The water jacket covers only three-fourths of the surface of the cylinder, one-quarter being taken up by the air ports, which is another defect in construction. The working pressure varies from seventy-five to eighty-five pounds, blowing off at eighty-five pounds. The com-

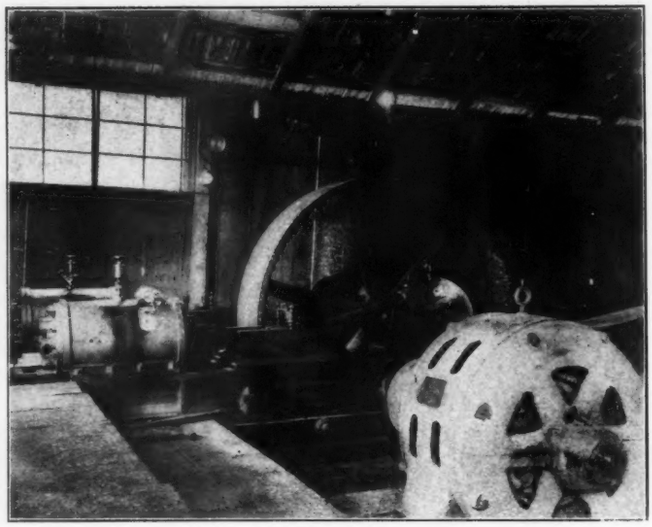


FIGURE 10. THE 30 HORSEPOWER MOTOR AND COMPRESSOR AT THE SOUTH SPRING HILL MINE.

pressor runs fifty-nine revolutions per minute, the valves being of the ordinary poppet type.

In driving this machine, a 30-horsepower General Electirc "Form K" compensator type induction motor is used; speed, 900 revolutions per minute, voltage 550, the current being transformed from 10,000 volts in a separate building, about 250 feet from compressor house, and measured on the low tension side by an intergrating Schallenberger wattmeter, 746 watts being considered the equivalent of a mechanical horsepower. The current is transmitted from the Standard Electric Company's plant, near Jackson, Amador County, Cal., a distance of eight miles. The price per horsepower by meter measurement is $6.50 per month, which is the maximum rate, and which is reduced somewhat according to the amount of horsepower contracted for above a certain amount. The compressor pumps directly to a small receiver, in this case too small by 500 cubic feet, the total storage being only about 100 cubic feet, allowing altogether too sudden fluctuations in air pressure, and not enough to carry all the air compressed during the small periods of idleness of power drills and hoisting engine, without blowing off air.

This brings up the important point in compressor practice, that blowing off air is a large item of expense, is wasteful and is an apparent negligence of proper installation, but for some unaccountable reason it is generally considered unavoidable in a compressor plant. Provide plenty of storage capacity, and install the right size of compressor, and compressed air will be an economical and not an expensive commodity, as is the opinion of most of its users.

In the case of the South Spring Hill Mine, the blow-off of the receiver is so arranged that it empties into the steam boiler, where it is re-heated and used in the hoisting engine, passing in just above the water line through the front end of the boiler, as shown in the illustration herewith. When the power drills are not operating, the lever is raised and all the air passes to the boiler for hoisting purposes. Attention is called to the accompanying sketch already referred to and showing the general arrangement of the plant. Where it is possible to do so, elbows are avoided and long sweeps, made by bending the pipe, are used; these bends being made very carefully to avoid any crushing of the side of the pipe.

Where pressure in the receiver rises above seventy-five pounds per square inch, it overcomes the weight and escapes through the three-inch check valve, whence it passes out through the side opening of two and one half inch tee (through which passes the stem shown in dotted lines), and thence to the steam boiler. A check valve shown in the illustration prevents the steam from backing out of the boiler when the air is below steam pressure; this arrangement makes the blow-off on the steam boiler to be the blow-off of the compressor. Air is used cold in the power drills, but in the engine it is re-heated to about the temperature of steam at forty pounds pressure.

The average consumption of fuel used in combination with electricity in this plant for sixty days was:

Twenty horsepower per dry at a cost of	$270 00
Wood burned in meantime, 37½ cords at $6	225.00
Total cost for power	$494.00

Under former conditions it required:

Two cords of pine wood per day, 120 cords at $6	$ 720 00
Water power for compressor (very favorable conditions), two months	350 00
Total by wood and water	$1070 00
Tons of rock broken by power drills, and hoisted 550 feet	= 2667
Tons of water hoisted 600 feet	= 3600

Under the present conditions should the power drills and hoisting engine be idle all at once for more than one minute, the air blows off because of the lack of storage, which, as soon as rectified, should make a difference of at least 10 cords of wood. Electricity at $6.50 per horsepower month is at the rate of about 21 cents per horsepower for twenty-four hours. Consuming, as this plant does, about twenty horsepower per day, means $4.50 per day to produce enough air at eighty pounds pressure to operate two power drills (3¼-inch cylinders), and leave a surplus for the hoisting engine sufficient to save the use of over one and one-quarter cords of wood per day. Had all the air pumped to eighty pounds been conserved by ample storage, the use of less than

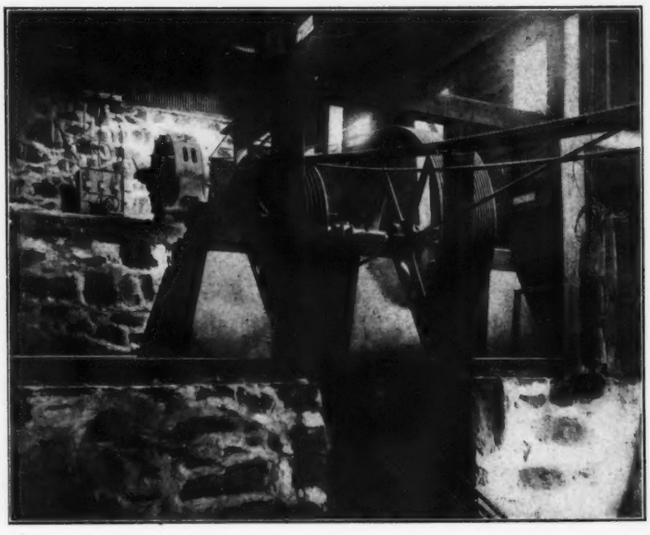
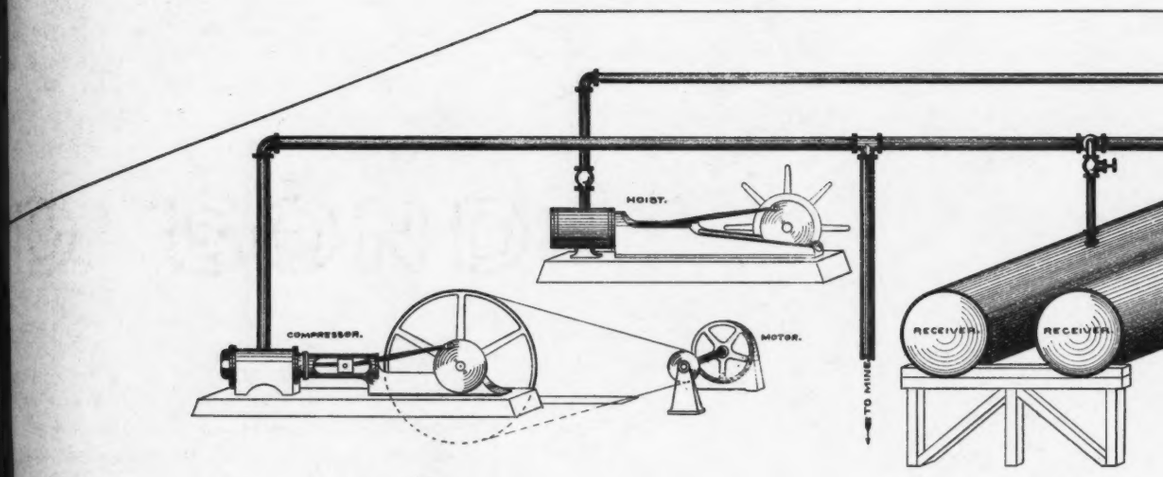
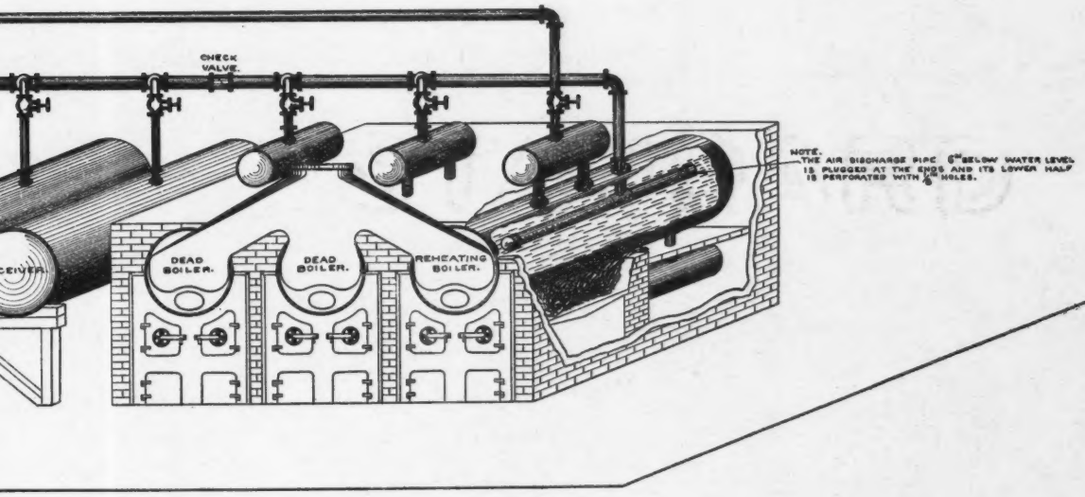


FIGURE 11. AT THE KEYSTONE MINE A 300 HORSEPOWER INDUCTION MOTOR RUNS A COMPRESSOR THROUGH A ROPE DRIVE.

one-half cord of wood would have been sufficient for all re-heating purposes, and supply steam at times when air pressure was low.

The results obtained by the use of compressed air for hoisting purposes in the above instances, should convince the most skeptical mind that it is economy to use compressed air for hoisting with electric power at $6.50 per


HOIST.
COMPRESSOR.
MOTOR.
TO MINE
RECEIVER.
RECEIVER.


CHECK VALVE.
DEAD BOILER.
DEAD BOILER.
REHEATING BOILER.
NOTE.
THE AIR DISCHARGE PIPE 6" BELOW WATER LEVEL IS PLUGGED AT THE ENDS AND ITS LOWER HALF IS PERFORATED WITH 1/8" HOLES.

COMPRESSED AIR ARRANGEMENT
FOR
REHEATING AND HOISTING PURPOSES.
MAY 9th. 1903.

horsepower per month against the prevailing prices of fuel. At the present time there are several large compressed air plants in course of erection in Amador County, all of which are to be electrically driven, and re-heated air is to be used for hoisting.

The diagram herewith shows the arrangement of compressor and receivers that have given such excellent service at the Lightner Mine. It will be observed that a check valve is placed in the relief pipe between the mine receivers and the boilers. Any excess of air flows through check valve into the boilers, and the air that is used for hoisting is all taken from the re-heating boiler; the air passing into this boiler enters through a perforated pipe, which is submerged about six inches below the surface of the hot water. This arrangement permits all of the air to come in contact with the hot water, and is very rapidly heated. As air is drawn from this boiler by the regular steam pipe, and the pressure is lowered, air from the other boilers and receivers immediately flows in, thus utilizing all of the receiver capacity for the hoist during moments of heavy demand. Between skips, the compressor has time to re-charge the receivers.

With an installation of this kind properly proportioned as regards motor, compressor and receiver capacities, to my mind, it leaves little to be desired from the point of economy, convenience and reliability.

As a matter of some interest, I submit here some photographs and data representative of the application of electric power for mining purposes.

Figure 1 shows the town of Sutter Creek nesting among the hills of the mother lode in Amador County, Cal.

FIGURE 12. THE 150 HORSEPOWER INDUCTION MOTOR AT THE KEYSTONE MILL.

Figure 2 is an excellent picture of the Oneida Mine and Mill.

Figure 3 is a 30-horsepower induction motor driving the Oneida concentrators.

Figure 4 shows the 60-stamp mill at the Oneida Mine driven by a 150-horsepower induction motor.

Figure 5 gives the test of engine at the Royal Mine, Calaveras County, Cal., April, 1902.

Figure 6 is a 150-horsepower motor driving the air compressor at the Oneida.

Figure 7 shows a 150 and 30-horsepower motor as installed at the Oneida Mill. The small motor drives the concentrators independently.

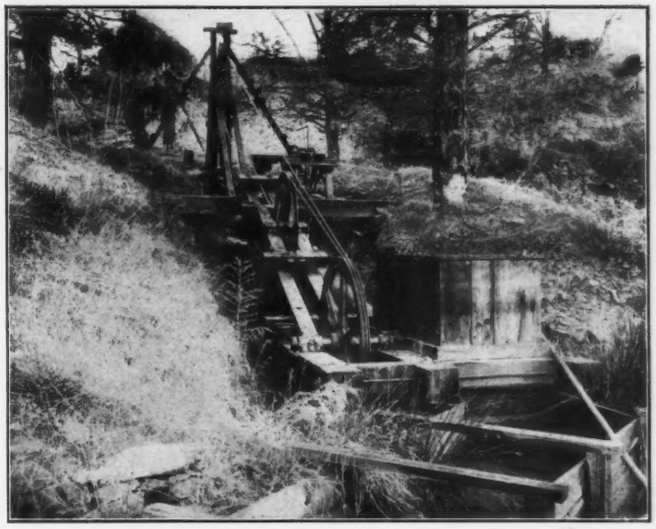


FIGURE 13. A RELIC OF THE PAST—A WATER WHEEL ROPE DRIVE.

Figure 8 is the 150-horsepower motor driving the compressor, sawmill, etc., at the Lightner.

Figure 9 is the 100-horsepower motor driving the Lightner Mill.

Figure 10 shows the 30-horsepower motor and compressor as operated at the South Spring Hill Mine.

Figure 11 shows the 300-horsepower motor and rope drive at the Keystone.

Figure 12 shows the 150-horsepower induction motor at the Keystone Mill.

Figure 13 shows a method of generating and transmitting power that will soon be a thing of the past on the Mother Lode.

KEYSTONE

The old Keystone Mill consisted of 40 725-pound stamps, 96 drops, 7.5-inch fall, and 16 concentrators. The total power required was 85-horsepower, or 2.12 horsepower per stamp. When this mill was operated by steam, using pine wood for fuel, 7 cords per day were consumed; this at $5.00 per cord = $35.00 per day, or $1050.00 per month; add to this the wages of two firemen = $1200.00 per month. The cost of electric power at $6.50 per horsepower per month = 85 × $6.50 = $552.50, showing a saving of $647.50 per month.

This mill has recently been increased to 60 stamps and 24 concentrators. The new stamps are 1000-pound, making 100 drops, 5.5-inch fall. The mill is now driven by a 150-horsepower induction motor. They have also installed at this mine a 300-horsepower induction motor for driving a 2-stage Norwalk air compressor, and a 30-horsepower motor for operating the sawmill, making a total installation of 480 horsepower. This mine is also using compressed air for drills and hoisting. The motors and rope drive are shown in figure 11.

CENTRAL EUREKA

Measurements made on the Central Eureka Mill showed a consumption of 46 horsepower for 20 850-pound stamps, 90 drops, 6.5-inch fall, including 8 concentrators. This is at an average of 2.3 horsepower per stamp. The mill was driven by a 50-horsepower induction motor. Since this data was obtained the owners have increased the capacity of the mill to 40 stamps, and have installed a 100-horsepower motor to drive it. Preparations are now being made to install an air compressor, to be driven by the 50-horsepower motor taken from their mill, and when this is done compressed air will be used for drilling and hoisting. The total electrical installation will then be:

Mill	100.	horsepower
Compressor	50.	"
Rock Crusher	12.5	"
Blower	7.5	"
	170.	horsepower

ONEIDA

The Oneida Mill is running 60 1100-pound stamps, 94 drops, 7.5-inch fall. The power required to run the mill, including 30 concentrators, is 175 horsepower, or 2.91 horsepower per stamp. The stamps are driven by 150-hors-e power induction motor, and the concentrators are driven by a 30-horsepower motor; the motors, batteries and concentrators are shown in figures 3 and 4.

This mine is also using a 50-horsepower motor on its rock crusher, a 75-horsepower motor in its sawmill and a 125-horsepower synchronous motor driving its air compressor. It is preparing to install a 125-horsepower motor in the mine for driving a pump, which will make a total installation of 555 horsepower. The total power cost per ton of ore milled at this mine is about 30 cents. The cost of power for the mill when all stamps are run continuously is $1137.50 per month. This mine is hoisting and pumping by steam with oil for fuel.

I might mention that a 100-horsepower motor has recently been installed in this mine for driving a pump, and is doing excellent work. I understand this pump is to be the subject of a paper to be presented at this meeting. My belief is that electrically driven pumps will soon be a common thing on the Mother Lode, and from the point of efficiency and convenience, it certainly leads any of the methods now employed.

It is well understood that the ordinary steam pump is a very extravagant piece of apparatus, owing to the fact that it takes steam full stroke, and makes no pretense of cutting off in order to use the steam expansively; this is especially true when compressed air is used instead of steam, for it must be distinctly understood that economical results can not be obtained with compressed air, unless the benefits to be derived from expansion are taken advantage of. In order, then, to realize the best results from compressed air for pumping purposes, an engine type pump should be used with an adjustable cut-off, thus enabling the valves to be set for the duty the pump is to perform.

While compressed air affords a very convenient method of pumping the difference in efficiency between that method and electrically driven pumps, permits of no argument, electricity having fully 30 per cent. the advantage.

CALCULATION OF A 50,000-HORSEPOWER, 80,000-VOLT, 200-MILE TRANSMISSION LINE.*

BY C. W. HUTTON AND R. CROWELL.

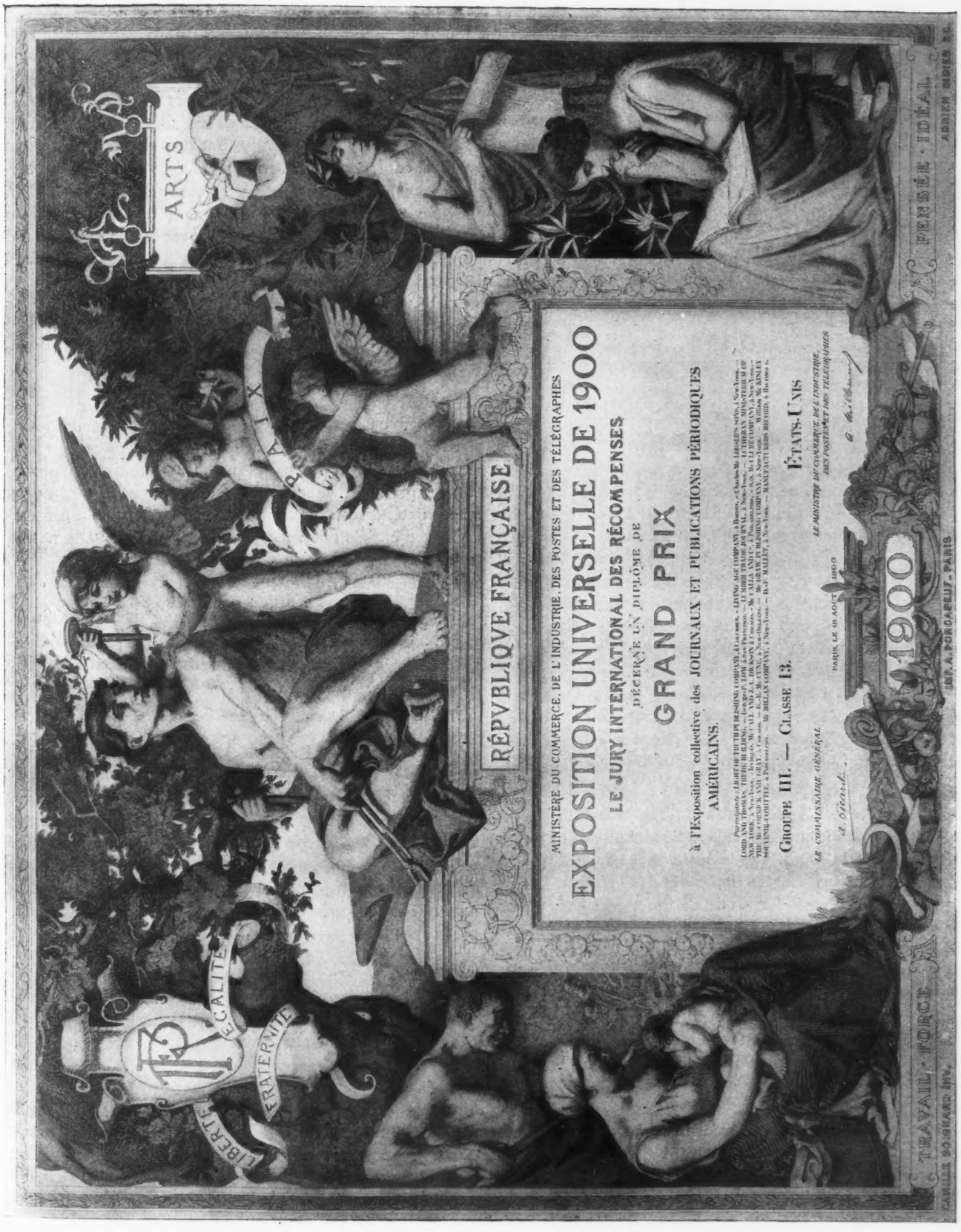
WE cannot do better in opening this subject than quote a few lines from a recent article entitled "The Longest Power Transmission in the World," by a well known electrical writer, Mr. T. C. Martin, which he starts with the following words:

That compensatory plan of Providence which gave England her coal beds in lieu of sunshine has endowed California with one of the brightest climates in the world, but left her without resources of fuel. Whether it is better for a country to live on its geology or its geography has remained a moot question, but usually coal mining regions have little to recommend them as places of residence after the deposits are exhausted. Newcastle and Pittsburg have no vogue as pleasure resorts, but long after their pits and volcanoes of pent up energy, hushed and empty, lie in black silence, picturesque Switzerlands and Californias will be drawing cheerfully upon the renewed bounty of the daily blue skies and fleecy clouds. The chief future use of China appears to consist in its supply of black coal; but when that in turn is worked out the melting glaciers of the Jungfrau, the bubbling streams of the snow-clad Sierras and the rushing tide of the Niagara gorge will still be here to give up to us, not alone their beauty, but their strength. It is doubtless satisfactory to know that if you want warmth and light you can dig it up, but when the digging of the black coal dwindles, hand to mouth diurnal dependence upon sunshine and showers for the "white coal" that must largely take its place will be a mark of the highest economy and best efficiency on the part of our engineers.

It will be noted from the remarks of our friend that his conception of us and ours undoubtedly fitted the conditions a few years ago. But he has either forgotten, has not been informed of, or, at any rate, has failed to recognize the fact that the strenuous Anglo-Saxon, to whom is attributed the pushing to every extreme of pioneership and achievement, after being filled with copious draughts of Nature's most invigorating tonic, a glorious climate, was not content with the many things he found immediately above and below the surface, and that, while puncturing the bowels of the earth in search of other things, has found in apparent abundance one of the greatest of Nature's energy producing elements—the best fuel oil on earth. In recognition of this it is but fitting to say that had the great oil fields been discovered previous to the advent of long distance electrical power transmission, the great impetus imparted to the transmission interests generally, through Western enterprise, would have been perceptibly discounted, as to time and magnitude. However, great transmissions became successfully launched. Then, later, the advent of oil placed a rival commodity on the market. The future success, therefore, of either industry for particular conditions will be determined by "The Survival of the Fittest."

*A paper presented to the Sixth Annual Convention of the Pacific Coast Electric Transmission Association, June 17-18, 1902.

(Continued on page 138.)



FACSIMILE OF THE DIPLOMA AWARDED BY THE PARIS EXPOSITION, 1900, TO GEO. P. LOW FOR EXHIBIT OF "THE JOURNAL OF ELECTRICITY, POWER AND GAS."

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VOLUME XII JULY, 1902 NUMBER 7

EDITORIAL.

THE SIXTH TRANSMISSION CONVENTION.

The Sixth Annual Convention of the Pacific Coast Electric Transmission Association, held in the Palace Hotel, San Francisco, on June 17th and 18th, will be remembered by the majority of attendants as an all-work-and-no-play session, for aside from a superb stereopticon exhibition there was naught to leaven the unceasing grist of two days and two nights. There was no social side whatever to the session – not even a luncheon—but the papers read were of unusual excellence and the administration of the duties of the presiding officer by Dr. Van Norden was so truly exemplary that the convention was of great value.

Dr. Van Norden's presidential address was a masterful presentation of the commercial and financial sides of transmission undertakings—the sides which have hitherto found little if any treatment by the association. "An Equation of Success" for transmission undertakings, or for any specific transmission undertaking, will be exceedingly hard to find, but nevertheless it is meet that we should be reminded of the most potent and most hidden factor of all in the building and profitable operation of these mighty exterprises. And when a brainy man of much experience discusses the subject in the light of his matured judgment, it is well to deliberate upon his words profoundly.

Hydraulic engineering in transmission work is a theme which was opened for discussion by Mr. Eastwood's paper, but it is unfortunate that the lateness of the hour of its reading precluded the thorough discussion which the importance of the subject demands. Some of Mr. Eastwood's views, and notably those upon the theory of nozzle discharge, will be taken exception to, but regardless of this the paper presents a vexed problem in a way which is commendable. Undoubtedly the most interesting idea advanced during the discussion of the subject was the belief expressed by Mr. W. Stuart Smith that certain pittings frequently found in nozzles and by almost universal consent asbribed to erosion of the jet, is due to simple oxydation, just as the backs of propeller blades are pitted from oxydation. This suggestion not only possesses marked originality, but it is deserving of most careful consideration, for if the theory advanced is correct, as it might easily be under certain conditions, then the elimination of that certain pitting resolves itself into so designing a nozzle that the occurance of a vacuum and the liberation of oxygen in a nascent state thereby will become an impossibility. As these forms go to press Mr. W. Stuart Smith has contributed an article to THE JOURNAL which discusses the subject exhaustively and presents conclusions which appear to be irresistable. The article will appear in these columns for August.

The executive session of the convention was characterized by two important actions which are of general interest. The first consists in the adoption of a resolution expressing the sentiment of the convention regarding the proposed restriction of overhead circuits to lines carrying potentials not in excess of 2500 volts alternating current. This resolution reads as follows:

Inasmuch as the Underwriters National Electric Association is reported to have under consideration the enactment of a rule restricting the use of overhead high tension distribution circuits carrying alternating current potentials in excess of 2500 volts in cities or near insured buildings; and

WHEREAS, The use of such circuits has become a universal and common practice which is not unduly hazardous when provided with adequate safeguards such as are characteristic of modern electrical engineering practice; therefore, be it

Resolved, That the enactment of such restriction is unwarranted, unjustifiable and distinctly prejudicial to the vested interests which we represent.

These words have no uncertainty in their meaning, and when the electrical interests of the entire country shall have given similar utterance to their convictions regarding the proposed enactment, it will be found that equal definiteness in the same strain shall be the universal protest.

While the subject which gave being to the above resolution cannot be discussed in other than condemnatory vein, it is not the disposition of these columes to do so beyond to announce their disapproval of the proposed restriction and their approval of the resolution given in word and in spirit. Rather than utter denunciation, however deserved, it is better to point out the belief that the agitation in the direction of the proposed enactment is altogether a perversion of effort. It would be the part of wisdom to regulate and standardize each and every detail of high tension pole line construction; to stipulate requirements that will surround high tension pole lines with each and every safeguard known to engineering is a

bounden duty; and to enact legislation that will, for instance, absolutely prohibit the handling of live wires carrying voltages perilous to life, as well as to define a danger zone about high tension lines within which no lineman may venture on the pole without incurring liability to penalty would be a public benefaction. Then, again, the altogether too frequent killing of linemen while in the discharge of their duties makes it self-evident that something must be done to minimize these deplorable happenings. The great majority of such deaths are due to either carelessness or ignorance on the part of the men themselves. They either fail to appreciate the danger of their calling or they become reckless, and, trusting to luck, take most desperate chances without thought of their peril. Linemen should be licensed, even as steam engineers are examined and licensed, for carelessness or incompetency on their part may imperil property as well as life.

Let institutes and associations and conference committees and legislative bodies work along these lines all they may, and the encouragements of all will go with their labors; but let them once and forever dismiss all thought of the prohibition of high tension pole lines for, in the language of the resolution of the Transmission Association, such an action would be unwarranted and unjustifiable.

The second act of the executive session of the convention which is of general interest consisted in amending the constitution and by-laws of the association so that its membership shall be divided into four classes, viz., honorary members, regular members, associate engineers and associate members. This gives the independent engineer of any profession which is allied to electrical transmission interests in any way an opportunity for affiliation with the Association on a basis identical with that of regular members as to dues, and with privileges as full as those of honorary and associate members. In brief they have every membership privilege possessed by regular members except that of participating in executive sessions. It is now in order for engineers, whatever may be their employment or whatever their profession, to apply for membership in the associate engineers class, for this is the section of the association which is destined to lead the others not only numerically but in advantages to be derived from the discussion of engineering problems which ever arise in the work of high tension transmission.

It is now demonstrated beyond question that San Francisco is not the proper place in which to hold the annual conventions of the Transmission Association. Every transmission man of the Pacific Coast has business to attend to when he arrives in San Francisco, and though he may come here fully intending to devote his time to the work of the convention, yet this intent gives way to other business which is uppermost on his mind and convention matters take second place. The constant attendance at past transmission conventions has varied in inverse ratio to the distance at which the meeting was held from San Francisco, while the real success of the past conventions may perhaps be measured in direct ratio with the attendance. A good session was held at the Cliff House, a better one by far was that held year before last at the Tavern of Tamalpais, but the best of all from many standpoints was the one held last year at San Jose. Still the recent convention was an excellent one—in many ways it was far superior to any which preceded it—but the fact remains that men cannot and will not get down to business when conditions are such that but six minutes out of every sixty are devoted to convention work. When in the midst of his company's business the transmission man leads a strenuous existence, and as he always has important business pressing when in San Francisco, the chances of his being a constant attendant at a convention while in the metropolis are deucedly slim. Then, as stated, the sixth transmission convention was a session of all work and no play. This fact, coupled with that of the place of meeting, makes the session notable chiefly in the lessons which it has administered.

A NEW ERA IN THE GAS WORLD.

In an invaluable paper read before the Tenth Annual Meeting of the Pacific Coast Gas Association held in San Francisco during the present month, Mr. John L. Howard discussed the fuel conditions in California, and in doing so pointed out the many influences which the development of long distance electric power transmissions are exerting on the gas industry of the State.

Something over a year prior to the organization of the Pacific Coast Gas Association, now nine years ago, the then abnormally high cost of power in southern California gave incentive for the installation of the famous Pomona plant, which was the forerunner of practical high pressure electric transmission in the world. Then came a decade of tribulation, of experiment, of development, of progress, and of triumph, until at last electric transmission has become the predominating influence in the supply of the power markets of the West. Gas engineers can never know or even dimly appreciate the difficulties with which the commercial and technical exploitation of earlier electric transmission enterprises were attended, but they do know and duly respect the very forceful character of the now ten-year-old industry.

As it enters its second decade of existance, electric transmission is happy to find that its principles and ideas are about to be wrought over to the lasting betterment of its closest of kindred—the gas industry. The era of the development of high pressure gas distribution is upon us, and however much its successful outcome at very high pressures and over extremely long distances may be beclouded in inherent perplexities and seemingly unsolvable difficulties, let its engineers find encouragement in the glorious triumphs achieved in electric transmission and take firm heart threfrom for the successful prosecution of the new work which they have in hand.

CALCULATION OF A 50,000-HORSEPOWER, 80,000-VOLT, 200-MILE TRANSMISSION LINE.

(Continued from page 134.)

Cases have come to the notice of the writers where, with oil for fuel, burned under boilers under good conditions and by the use of a moderate sized compound condensing engine, power can be produced at a cost of $27.60 per indicated horsepower per year of 313 working days of twenty-four hours each. The corresponding cost per horsepower for labor in this case amounts to $7.00, making a total cost for fuel and labor of $34.60 per indicated horsepower per year of 313 working days of twenty-four hours each. This is on the basis of oil free from water and sand at 70 cents per barrel, which would, as a fuel, be equivalent to a good quality of anthracite coal at $2.10 per short ton, and a steam engine performance of three and one-half pounds of coal or one and three-fourths pounds of oil per indicated horsepower hour.

As will be seen from the above, three barrels, forty-two gallons each, of good clean oil of the specific gravity of 92 per cent. is equivalent to one ton of good anthracite coal. When it is therefore considered that the long distance electric power transmission plants of the West have to compete with fuel at prices which even Eastern power consumers in many instances would be glad to obtain, and which represent a saving of approximately 40 per cent. over the conditions of a few years ago, and that such plants are expanding and their numbers multiplying under such strenuous competition, we cannot but be mindful of the fact that exceedingly long lines, and the extremely high voltages, have been a commercial as well as an engineering success.

Heretofore our Western transmission plants for the utilization of water power have consisted of generating plants of small individual capacity as compared with some which, in the near future, are likely to be installed, and to which public attention is constantly being attracted. As the stability and close regulating qualities of such plants will be largely influenced by the proper construction and working qualities of the transmission lines, it was thought it would be interesting to consider such a line from an electrical standpoint. This, therefore, is our excuse for presenting our subject at this time. There has been considerable discussion of late among the coast engineers as to the value of the substitution of latticed steel towers for the wooden poles generally used for line supports. It would appear from the standpoint of the stability and lasting qualities that tower construction would be the best, providing the cost is not excessive. We have not investigated this cost particularly, but understand from those who have that the cost of towers would not make them impracticable for the purpose. The height and distance between towers would be determined by the conditions of cost and good construction. In determining what pressure would be required to meet economic considerations, we have used a rough and ready rule given to us by Mr. Charles F. Scott, which is "the pressure in thousands of volts will be equal to one-third of the number of miles you wish to transmit." Assuming a 200-mile transmission on this basis, the number of thousands of volts necessary would be slightly less than seventy, but as the tower construction would cost considerable in excess of poles, we could help even up matters by adopting 80,000 volts as the line pressure at the receiver end.

Four cases were considered to determine which would give the best results: First, two three-wire, three-phase circuits, operated at sixty cycles per second; second, two three-wire, three-phase circuits, operated at thirty cycles per second; third, four three-wire, three-phase circuits, operated at sixty cycles per second; and fourth, four three-wire, three-phase circuits, operated at thirty cycles per second. To calculate the size of aluminum wire necessary we have the following data: Fifty thousand horsepower to be transmitted 200 miles at 80,000 volts, the wires to be at the points of equilateral triangles and spaced twelve feet between centers, the power factor of the delivered load to be 85 per cent. As a preliminary calculation we assume a 15 per cent. loss of the delivered energy:

Let

I = Current in one wire.
D = Distance of transmission (one way) in feet.
W = Total watts delivered at receiving end of circuit.
P = Per cent. loss in line of W.
E = Voltage between main conductors at receiving end of circuit.
R = Resistance of one wire.
$C.\ M.$ = Area of conductor in circular mils.
$\cos\theta$ = Power factor of load.
C = Capacity in microfarads between one wire and the neutral point.
L = Self-induction in henries of one wire.
Ic = Charging current in one wire.
$L\omega$ = Inductance in ohms of one wire.
d = Distance between wires in inches.
r = Radius of wire in inches.

The size of wire is obtained as follows:

$$P=\frac{3\,I^2\,R\times 100}{W} \quad \text{and} \quad W=\sqrt{3}\,E\,I\cos\theta$$

substituting the value of I found from the second equation we have:

$$P=\frac{3\,R\times 100}{W}\times\frac{W^2}{3\,E^2\cos^2\theta}=\frac{DW\times 10.8\times 100}{C.M.\cos^2\theta\times E^2}$$

for copper, since the resistance of one mil foot of copper is 10.8 ohms.

Taking the conductivity of aluminum as 60 per cent. of that of copper, we have for aluminum, and power factor of 85 per cent. of the delivered load,

$$P=\frac{DW\times 18\times 100}{C.M.\times\cos^2\theta\times E^2}=\frac{DW\times 2500}{C.M.\times E^2}$$

Assuming 15 per cent. energy loss we have:

$$C.\ M.=\frac{DW\times 2500}{P\times E^2}=\frac{5280\times 200\times 50{,}000\times 746\times 2500}{15\times 80{,}000\times 80{,}000}=1{,}025{,}000$$

We can use a 1,000,000 circular mil cable which will give a loss in per cent. of 15.4, as follows:

$$P=\frac{5280\times 200\times 50{,}000\times 746\times 2500}{1{,}000{,}000\times 80{,}000\times 80{,}000}=15.4$$

To insure reliability of service we have assumed two separate circuits of 500,000 C. M. stranded aluminum of

.82 inches diameter and 33.47 milli-ohms resistance per 1000 feet.

Calculating the self-induction of one wire from the formula:

$$L=\frac{1}{\sqrt{3}}\times.000558\left[2.303\ log_{10}\frac{d}{r}+\frac{1}{4}\right]\times\frac{D}{5280}$$

$$L=\frac{1}{\sqrt{3}}\times.000558\left[2.303\ log_{10}\frac{144}{.82/2}+\frac{1}{4}\right]\times200=$$

$L=.393$ henries.

Taking the frequency as sixty cycles per second we have:

$\omega=2\pi60=376.8.$

$L\omega=.393\times376.8=148$ ohms inductance per wire.

The capacity of one wire is:

$$C=\frac{.0776\times\frac{D}{5280}}{2\ log_{10}\frac{d}{r}}=\frac{.0776\times200}{2\ log_{10}\frac{144}{.82/2}}=3.05 \text{ microfarads.}$$

The charging current per wire is:

$$Ic=\frac{E\,C\times2\pi f}{\sqrt{3}\times10^{6}}=\frac{80{,}000\times3.05\times2\pi60}{1.73\times1{,}000{,}000}=53 \text{ amperes.}$$

The resistance per wire is:

$R=.03347\times5.28\times200=35.34$ ohms.

The current due to a delivered load of 25,000 horse-power over one circuit is per wire:

$$I=\frac{W}{\sqrt{3}\,E\cos\theta}=\frac{25{,}000\times746}{1.73\times80{,}000\times.85}=158 \text{ amperes.}$$

The power component of this load current is:

$I\cos\theta=158\times.85=134$ amperes.

The wattless component of this load current is:

$I\sin\theta=158\times.526=83$ amperes.

The former being the vector sum of the two latter.

In figures 1, 2, 3 and 4 let

$ab=-j\frac{Ic\,R}{2}$ the resistance drop due to charging current.

$bc=-\frac{Ic\,L\,\omega}{2}$ the reactive drop due to charging current.

$cd=+I\cos\theta\,R$ the resistance drop due to the power component of the load current.

$de=-j\,I\cos\theta\,L\,\omega$ the reactive drop due to the power component of the load current.

$ef=+j\,I\sin\theta\,R$ the resistance drop due to the wattless component of the load current.

$fg=+I\sin\theta\,L\,\omega$ the reactive drop due to the wattless component of the load current.

		60 cycles	30 cycles
$ab=-j\frac{Ic\,R}{2}$	$=\frac{53\times35.34}{2}=$	937 volts	468 volts
$bc=-\frac{Ic\,L\,\omega}{2}$	$=\frac{53\times148}{2}=$	3,925 "	981 "
$cd=+I\cos\theta\,R$	$=134\times35.34=$	4,770 "	4,770 "
$de=-j\,I\cos\theta\,L\,\omega$	$=134\times148=$	20,000 "	10,000 "
$ef=+j\,I\sin\theta\,R$	$=83\times35.34=$	2,950 "	2,950 "
$fg=+I\sin\theta\,L\,\omega$	$=83\times148=$	12,320 "	6,160 "

The corresponding volts drop at thirty cycles, which are diagrammatically shown in figure 2, are easily deduced from those at sixty cycles, since at thirty cycles the charging current is reduced one-half, as also the inductance, the other factors remaining the same.

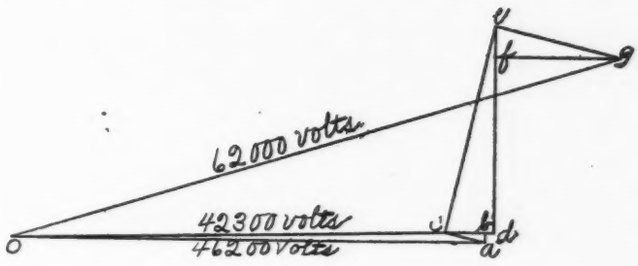


FIGURE 1.

Regulation of line, 34.2 per cent.
2—500,000 c. m. aluminum circuits 60 cycles.
Charging current per wire, 53 amperes.
og = Generator voltage from neutral point of system.
oa = Receiver voltage from neutral point of system.
$og\times\sqrt{3}=107{,}500$ total generator voltage.
$oa\times\sqrt{3}=80{,}000$ total receiver voltage.

$ab=-j\frac{Ic\,R}{2}=\frac{53\times35.34}{2}=937$ volts.

$bc=-\frac{Ic\,L\omega}{2}=\frac{53\times148}{2}=3925$ volts.

$cd=+I\cos\theta\,R=134\times35.34=4770$ volts.

$de=-j\,I\cos\theta\,L\omega=134\times148=20{,}000$ volts.

$ef=+j\,I\sin\theta\,R=83\times35.34=2950$ volts.

$fg=+I\sin\theta\,L\omega=83\times148=12{,}320$ volts.

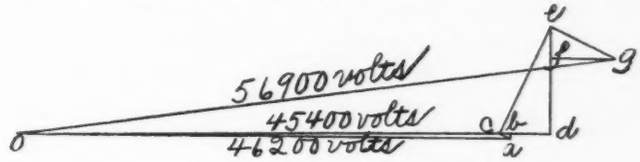


FIGURE 2.

Regulation of line, 23.2 per cent.
2—500,000 c. m. aluminum circuits 30 cycles.
Charging current per wire, 26½ amperes.
og = Generator voltage from neutral point of system.
oa = Receiver voltage from neutral point of system.
$og\times\sqrt{3}=98{,}500$ total generator voltage.
$oa\times\sqrt{3}=80{,}000$ total receiver voltage.

$ab=-j\frac{Ic\,R}{2}=\frac{26.5\times35.34}{2}=468$ volts.

$bc=-\frac{Ic\,L\omega}{2}=\frac{26.5\times74}{2}=981$ volts.

$cd=+I\cos\theta\,R=134\times35.34=4770$ volts.

$de=-j\,I\cos\theta=L\omega\,131\times74=10{,}000$ volts.

$ef=+j\,I\sin\theta\,R=83\times35.34=2950$ volts.

$fg=+I\sin\theta\,L\omega=83\times74=6160$ volts.

In order to improve the regulation we will calculate the above results for four circuits of 250,000 circular mils each, .59 inches in diameter, and 66.98 milli-ohms per 1000 feet resistance, all other conditions being the same as before. Calculating the self-induction of one wire from the formula:

$$L=\frac{1}{\sqrt{3}}\times.000558\left[2.303\ log_{10}\frac{144}{.59/2}+\frac{1}{4}\right]\times200=.415 \text{ henries.}$$

For a frequency of sixty cycles per second we have:

$L\omega=.415\times376.8=156$ ohms inductance per wire.

The capacity of one wire is, from the formula used before:

$$C=\frac{.0776\times200}{2\ log_{10}\frac{144}{59/2}}=2.89 \text{ microfarads.}$$

The charging current of one wire is:

$$Ic = \frac{80{,}000 \times 2.89 \times 2\pi 60}{1.73 \times 1{,}000{,}000} = 50 \text{ amperes.}$$

The resistance per wire is:

$R = .06698 \times 5.28 \times 200 = 70.7$ ohms.

The current due to a delivered load of 12,500 horsepower over one circuit is per wire:

$$I = \frac{12{,}500 \times 746}{1.73 \times 80{,}000 \times .85} = 79 \text{ amperes.}$$

The power component of the load current is:

$I \cos\theta = 79 \times .85 = 67.1$ amperes.

The wattless component of the load current is:

$I \sin\theta = 79 \times .526 = 41.5$ amperes.

		60 cycles	30 cycles
$ab = -j\frac{Ic\,R}{2}$	$= \frac{50\times 70\ 7}{2} =$	1,770 volts	885 volts
$bc = -\frac{Ic\,L\omega}{2}$	$= \frac{50\times 156}{2} =$	3,900 "	975 "
$cd = +I\cos\theta R$	$= 67\ 1\times 70.7 =$	4,750 "	4,750 "
$de = -jI\cos\theta L\omega$	$= 67\ 1\times 156 =$	10,460 "	5,230 "
$ef = +jI\sin\theta R$	$= 41.5\times 70.7 =$	2,935 "	2,935 "
$fg = +I\sin\theta L\omega$	$= 41.5\times 156 =$	6,470 "	3,235 "

Figures 3 and 4 show the results of the calculations for 60 cycles and 30 cycles respectively.

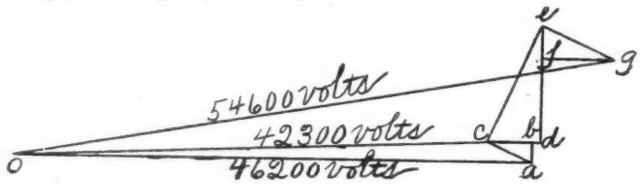


FIGURE 3.

Regulation of line, 18.2 per cent.
4—250,000 c. m. aluminum circuits 60 cycles.
Charging current per wire, 50 amperes.
og = Generator voltage from neutral point of system.
oa = Receiver voltage from neutral point of system.

$og \times 1\sqrt{3} = 94{,}500$ total generator voltage.

$oa \times 1\sqrt{3} = 80{,}000$ total receiver voltage.

$ab = -j\frac{Ic\,R}{2} = \frac{50\times 70.7}{2} = 1770$ volts.

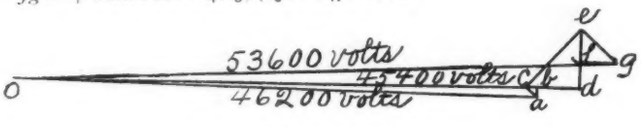
$bc = -\frac{Ic\,L\omega}{2} = \frac{50\times 156}{2} = 3900$ volts.

$cd = +I\cos\theta R = 67.1 + 70.7 = 4750$ volts.

$de = -jI\cos\theta L\omega = 67.1\times 156 = 10{,}460$ volts.

$ef = +jI\sin\theta R = 41.5\times 70.7 = 2935$ volts.

$fg = +I\sin\theta L\omega = 41.5\times 156 = 6470$ volts.



FIGTRE 4

Regulation of line, 16 per cent.
4—250,000 c. m. aluminum circuits 30 cycles.
Charging current per wire, 25 amperes.
og = Generator voltage from neutral point of system.
oa = Receiver voltage from neutral point of system.

$og \times 1\sqrt{3} = 92{,}800$ total generator voltage.

$oa \times 1\sqrt{3} = 80{,}000$ total receiver voltage.

$ab = -j\frac{Ic\,R}{2} = \frac{25\times 70.7}{2} = 885$ volts.

$bc = -\frac{Ic\,L\omega}{2} = \frac{25\times 78}{2} = 975$ volts.

$cd = +I\cos\theta R = 67.1\times 70.7 = 4750$ volts.

$de = -jI\cos\theta L\omega = 67.1\times 78 = 5230$ volts.

$ef = +jI\sin\theta R = 41.5\times 70.7 = 2935$ volts.

$fg = +I\sin\theta L\omega = 41.5\times 78 = 3235$ volts.

The length and positions of the lines OG and the lines OA in Figures 1, 2, 3 and 4 represent the corresponding voltage and phase of the pressure at the generator and receiver end respectively, when transmitting the full load at 85 per cent. power factor.

The principal thing to be noted from an examination of these diagrams is the relative lengths of the two lines OG and OA, as the difference in their lengths practically illustrates the loss in voltage and indicates the per cent. of regulation. In Figure 1 the generator pressure at full load in order to maintain the receiver pressure at 80,000 volts would have to be increased 34.2 per cent. above the receiver pressure, or to 107,500 volts. In Figure 2 the generator pressure under similar conditions to the above would be increased 23.2 per cent., or to 98,500 volts. In Figure 3 the generator pressure would be increased 18.2 per cent., or to 94,500 volts. In Figure 4 the generator pressure would be increased 16 per cent., or to 92,800 volts. As will be noted in Figures 3 and 4 the voltage regulation has been brought down to 18.2 per cent. and 16 per cent. respectively, which is only slightly above the percentage of energy loss, which was taken at 15.4 per cent.

Further subdivision of circuits would but slightly improve the regulation, while for every time the number of circuits is doubled and the size of the conductors halved the volt-amperes are nearly doubled.

In a plant of this size there would, perhaps, be installed at the generating end 50,000 kilowatt capacity in generators. The kilovolt amperes at 60 cycles necessary to charge the empty lines of two circuits illustrated by Figure 1 would be 13,450, or about 26.7 per cent. of the current capacity of the generators, while with the same frequency and twice as many circuits as in Figure 3, the kilovolt amperes necessary is for the four circuits 25,400, or a little over 50 per cent. of the current capacity of the generators. By reducing the cycles one-half of the first instance, however, we are then able to use twice the number of circuits, as illustrated in Figure 4, and still get approximately the same result as to kilovolt amperes necessary to charge the empty lines and greatly improve the line regulation. It is quite evident from the foregoing that for a plant of this size, where the bulk of its capacity would be used for driving motors, a frequency of 30 cycles, or even less, should be adopted, using motor-generator sets when lighting is required, thereby getting a much better voltage regulation for lighting than is shown in the average transmission plant of today.

PERSONAL.

CHARLES OSCAR POOLE, whose name has become prominent in transmission engineering circles, was born in Saulsbury, near Lowell, Mass., on June 17, 1859, and when 13 years old was taken by his parents to San Francisco, where a common school education was given him. Early in life, however, he came to a full realization of the deficiencies of his education for the avocation he had chosen to pursue, and as a result his common school education was supplemented by special courses in mathematics taken at private schools. This done, he at once entered into practical work in mechanics and mining, thus following to some extent in the footsteps of his father, whose business was that of a steam engineer.

CHARLES OSCAR POOLE.

To review briefly the career of the subject of this sketch, we find him, since reaching the age of 16, following consistently along a thorough line of training fitting him for engineering work. For instance, the first year after leaving school was spent in learning the carpenter trade. Then followed a year of blacksmithing, which, in turn, was succeeded by two years' apprenticeship in a machine shop. When hardly twenty he was the engineer of a gold mine in Grass Valley, California, as operator of its hoisting and pumping works. Soon after he emigrated to the State of Washington to accept employment as engineer, first in the Wilkinson and later in the Carbonade coal mines near Tacoma. Next he was located with the Seattle mines, near Seattle, as engineer, after which he became an engineer of the steam railway that hauled coal from the mines to Seattle. Subsequently he occupied the triple capacity of captain, engineer and owner of a steamboat which plied the waters of Elliott Bay and later of Lake Washington, at Seattle. The next change of avocation was rung in when the Oregon Improvement Company acquired by purchase the Franklyn coal mines, whereupon Mr. Poole was appointed master mechanic of the property, with entire charge of its steam and electrical engineering departments, consisting of a steam tramway system, hoists and pumps aggregating a capacity of 3000 horsepower, together with an electric lighting plant. This was in 1883, and he remained with the Frankly mines as master mechanic for a period of four years, during which he came to a realization of the possibilities resting in the development and application of electricity and the important part the new science was destined to play in industry.

This conviction which he held in these wonderful possibilities of the youthful science proved to be the turning point in Mr. Poole's career, and so deep rooted was this conviction that he promptly determined upon the relinquishment of the lucrative position which he held and the entrance upon the electrical field in the thorough-going practical manner which had always been so prominently his characteristic trait. The Franklyn mines were using Brush arc lighting apparatus that had been furnished by the California Electric Light Company, of San Francisco, which concern was at that time in fact the center of electrical activity on the Pacific Coast. To San Francisco, then, Mr. Poole promptly betook himself, where he as promptly secured employment as a dynamo tender in the Brush arc lighting station of the California Electric Light Company, the station which is now known as station A of the San Francisco Gas and Electric Company. This was in 1887, and within the brief period of six months he was promoted to the foremanship of the dynamo floor. A year later the repair shop department, a busy department in those days, was placed under his supervision, and next he was made superintendent of the company's arc lighting station on Townsend Street, known as station B, which contained at that time over 3000 horsepower in boilers, engines and generators, and remained for years the largest steam-driven station on the Pacific Coast. This position was held for four years, when Mr. Poole was promoted to the general superintendency of the Edison Light and Power Company, which had in the meantime succeeded to the business of the California Electric Light Company. The responsibilities of this latter position were great, embracing as they did the entire charge and physical management of that which was then practically the whole electric lighting and power industry of San Francisco, with the exception, of course, of its electric railways. Nevertheless after three years of service in this capacity he resigned the position on February 1, 1900, in order that he might accept the general superintendency of the entire system of the Standard Electric Company of California in charge of its construction and operation. In doing this he was consistently following his matured judgment in the belief he held as to the unlimited possibilities of long distance high tension power transmission, and while the work that he has accomplished in this present position has not been as yet published to the engineering world, the assurance may be vouchsafed that when the near future does make such publication, prompt recognition of the great engineering ability of the subject of this sketch will be universally accorded.

At present Mr. Poole's time and energies are being devoted to the upbuilding of the business of the Standard Electric Company, of which he is manager, and now that the great plant at Electra is in experimental operation, it would appear that the engineering portions of Mr. Poole's duties are about to lighten in their ardourness, but such is not the case, for announcement is made that work is to be at once undertaken in the building of a new plant for the Standard Electric Company on the Stanislaus River. The capacity of the installation at Electra is 15,000 horsepower, while the capacity of the new Stanislaus plant is to be 21,000 horsepower, which may be increased by the building of eight miles of canal to 42,000 horsepower. More than this, the United Gas and Electric Company, of which Mr. Poole is a director, has acquired by purchase the business comprising the electrical and gas industries of the city of San Jose and environs, thus completing the chain of electric and gas plants encircling the bay of San Francisco from the city limits of Oakland to those of San Francisco, a distance of about 100 miles, mostly through a rich and populous community. The power service for the operation of all these districts, as well as for the operation of the mines and mills of the mother lode in Amador and Calaveras counties, and the flour milling and other great interests of San Joaquin and Santa Clara counties, is all under the executive control of Mr. Poole as manager and supervising engineer, in view of which the position of trust and responsibility which he occupies will be readily appreciated.

Cordiality, geniality and whole souledness are the paramount of Mr. Poole's personal characteristics, and, if viewed from his business attainments, it should be stated that his qualifications are those most successful ones which are the fruits of close study, diligent investigation and hard work, coupled with an intimate personal acquaintance with the practical details of his work. Mr. Poole is above all else a thoroughly practical engineer, and as such his opinions will command thoughtful consideration the engineering world over. His tendencies have always been toward association and fraternization among his co-laborers. He was one of the charter members of the California Electrical Society, of which he was a prominent official for a number of years; he is a member of the American Institute of Electrical Engineers, of the American Society of Mechanical Engineers and of the Technical Society of the Pacific Coast, and prominent among the technical papers which bear his authorship are those discussing commutator troubles of Brush arc dynamos, the application of storage batteries to transmission systems and the construction of pole lines for extremely high tension long distance transmission work, the two papers last named having been delivered before annual conventions of the Pacific Coast Electric Transmission Association. And in concluding, let it be said that that the subject of this sketch may be accepted as typical of the successful self-made man of the second generation of the Pacific Coast.

Mr. ROBERT MCF. DOBLE, consulting engineer, of San Francisco, is in the East for the purpose of placing the orders for the machinery and material required for the construction of the 110 mile hydro-electric power transmission of the Guanajuato Power and Electric Company, in Mexico, for which company he is consulting and supervising engineer. Power is to be supplied to the famous silver mines at Guanajuato.

PROF. E. E. FARMER, formerly of Stanford University, but now located at Pittsfield, Mass., has issued cards announcing that the Probate Court of Berkshire County, Mass., on June 3d last, changed the name of Elmer E. Farmer to Elmer E. F. Creighton, in accordance with the wish of his late maternal grandfather, David Creighton.

VAN DER NAILLEN GRADUATES.

THE A. Van der Naillen School of Engineering recently held its thirty-eighth annual examination in practical, civil, mining, electrical and mechanical engineering, and surveying, architecture, drawing, assaying, cyaniding and metallurgy. The following successfully passed and were granted diplomas:

Mining Department—G. A. Ray, Gualala; S. M. Waterman, Cinnabar; F. A. Horvil, Stone Canyon; J. L. Hutchinson, Sumpter, Or.; H. Newman, San Francisco; M. C. Kerr, Johnsville; F. M. Lyle, San Francisco; D. W. Lyon, Grass Valley; W. H. James, Iowa Hill; J. A. Shields, Michigan Bluff; Charles E. Sloan, Memphis, Tenn.; D. G. B. McDowell, Nankin, Ohio; J. H. McDowell, Nankin, Ohio; W. O. Maxwell, Marshfield, Or.; E. F. Beck, Dayton, Nevada; O. W. Alderton, Ehrenberg, Ariz.; F. W. Saunders, Coos Bay.

Electrical Department—W. R. Dunbar, Murphys; H. E. Shuck, Sacramento; T. J. Zehmdner, Arcata; P. L. Gedney, San Diego; D. McDougall, San Francisco; W. T. Rutledge, San Bernardino; R. Dewart, Gilroy; E. L. Faust, Bakersfield; A. W. Hunt, Redlands; V. Urban, San Jose; H. G. Schemel, Gilroy; A. Mauser, Napa; J. W. Dooley, Sacramento; F. A. Dooley, Sacramento; A. H. Kennedy, Arabella; C. W. Cooper, Campbell; T. C. Thayer, Biggs; H. B. Patterson, Armona; R. Urquhart, Napa; C. T. McKenzie, Napa; H. A. Smith, Santa Barbara; J. T. Worthington, Waddington; F. W. Mielenz, Napa; F. Bond, Cloverdale; F. R. George, Los Angeles; E. Kreft, San Francisco; R. L. Cathy, Ferndale; E. R. Foster, Dixon; E. Schlessinger, San Francisco; L. A. Hedger, San Francisco; J. Minor, Arcata; J. P. Gericke, Tomales; H. F. Fahs, San Francisco; E. P. Mann, San Jose; O. G. Wilkes, Hillsboro, Or.; L. E. Wilkes, Hillsboro, Or.; E. Mayer, Butte, Mont.; L. T. Russell, Portland, Or.; S. C. Mills, Salt Lake, Utah; E. M. Hengell, Andover, S. D.; H. Piggott, Ontario, Canada; John Fletcher, Manila, P. I.; D. C. Rudolph, Lompoc.

Draughtsmen—R. Keeler, San Francisco; G. Fee, San Francisco; R. W. Cudworth, San Francisco; W. K. Blackburn, San Francisco; S. L. Sasella, Alma; J. F. McLaughlin, Port Blakely, Wash.

Asssyers—H. A. Kuns, Ingomar; D. Woodrun, San Francisco; H. B. Shaw, Sonoma; C. S. Bryant, Diamond; H. C. Guentische, San Francisco; W. T. James, San Francisco; C. L. Bosson, San Francisco; F. G. Blackhart, Angels; J. K. Wilson, Placerville; E. S. Beckett, Grizzly Flat; G. Messner, Callahans Flat; W. W. Thurston, Grass Valley; T. J. Douglass, Berkeley; J. Sklower, Berkeley; R. Mawbray, Salmon City, Idaho; C. W. Soule, Salmon City, Idaho; D. J. Mahoney, Glendale, Or.; L. L. Mann, Eleele, H. I.; G. R. Huggins, Murfreesboro, Tenn.; E. Williams, Nome, Alaska; G. Conlin, Victor, Colo.

The Electric Storage Battery Company, of Philadelphia, announces that Mr. G. F. Greenwood, 34 Empedrado Street, Havana, Cuba, has been appointed agent for the sale of "The Chloride Accumulator" in Cuba. All inquiries and business from this section should be forwarded to Mr. Greenwood, and will receive from him prompt attention.

AN ALTERNATING CURRENT CALCULATING DEVICE.

AN alternating current calculating device has been perfected by F. G. Baum, professor of electrical engineering of the Leland Stanford Junior University, for the use of electrical engineers for determining the regulation of a transformer, transmission line, or generator, or any combination of these, for any load and any power factor. It may also be used for making any synchronous motor calculation. No mathematical work is necessary. The device determines the results within one per cent. A pamphlet of twenty-two pages is sent by Prof. Baum with the device to explain its use. In this pamphlet methods of making measurements on transformers, transmission lines, generators and synchronous motors are given. Curves giving practical data on transmission lines are included.

With the calculating device the following questions concerning a synchronous motor may be immediately answered:

(1) What must be the excitation to give any desired power factor at any given load?

(2) What must be the excitation to give any percentage wattless current at any given load?

(3) What will be the current and power factor for any given excitation at any given load?

(4) What will be the angular swing of the motor for any given change in load?

(5) What is the maximum load the motor will carry before falling out of step!

(6) What percentage compounding must be given the field of a synchronous motor so that changes in load will not affect the pressure at its terminals?

The device will be forwarded to any address by Prof. Baum on receipt of $1.00.

LATEST CALIFORNIA TOPOGRAPHIC MAPS.

A number of interesting topographic sheets showing portions of California have recently been issued by the United States Geological Survey. The Redding sheet shows the country about the town of that name and the mountainous section of the upper Sacramento Valley. The Chico and Bidwell Bar sheets, which join, show a portion of the Sacramento Valley surrounding the town of Chico and the neighboring western foothills of the Sierra Nevada. The canyons of the North and Middle forks of Feather River are interesting features of these sheets. The Anaheim and Santa Ana sheets adjoin and show the comparatively thickly settled country along the lower course of the Santa Ana River. The diminutive stream into which this river suddenly shrinks on leaving the mountains is well indicated, as are the broad, nearly dry gravel beds into which it divides below. The more important irrigation canals of the region are also shown. The Big Trees sheet shows a section nearly in the heart of the Sierra Nevada, and is notable as indicating the location of the Calaveras groves of big trees. The shape, height and slope of all mountains are indicated by contours, and all the ordinary features appear in great detail.

The maps are now available at the usual government rate of 5 cents each, on application to the director of the United States Geological Survey, Washington.

LIGHTNING AND SYNCHRONOUS APPARATUS.

In answer to a query sent out by the National Electric Light Association as to what effect lightning will have on synchronous apparatus operated from transmission lines, Mr. C. O. Burrows, of Walla Walla, Wash., communicated that with single-phase apparatus lightning always causes step to be broken and generally burns out one or more coils of the generator. As a consequence of this the Walla Walla Gas and Electric Company has discarded single-phase synchronous apparatus.

Mr. Percy H. Thomas, of Pittsburg, in writing, speaks of THE JOURNAL, "whose excellence we all recognize."

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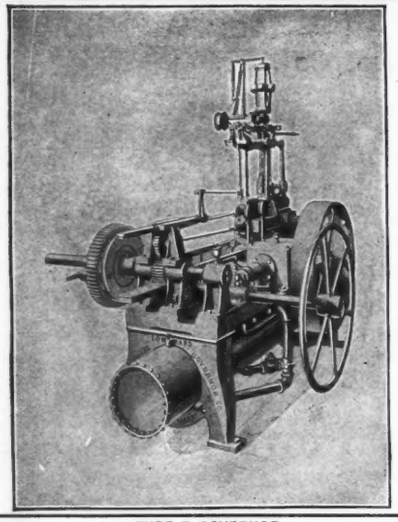

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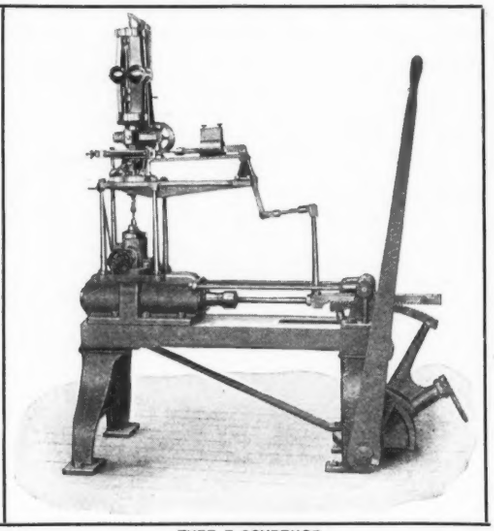

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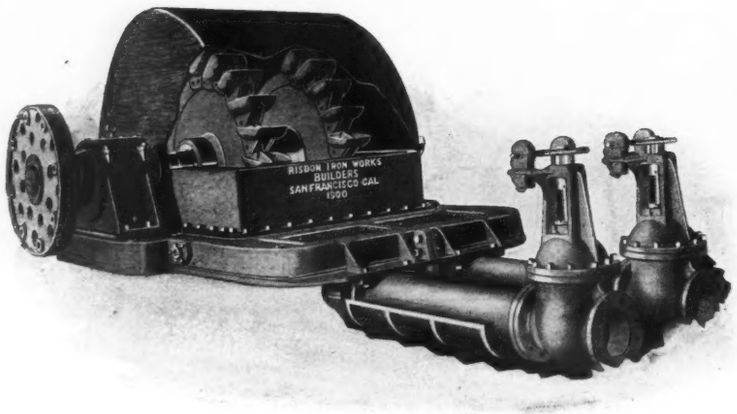

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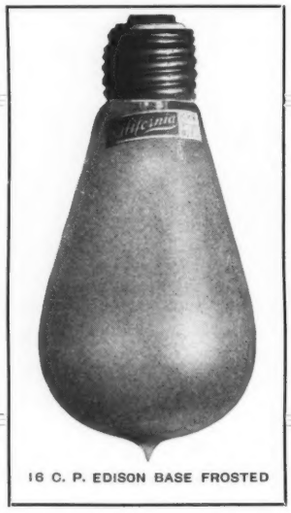

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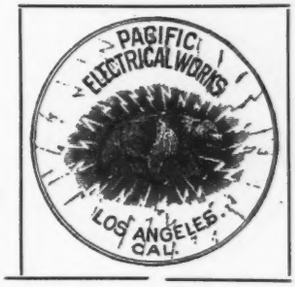

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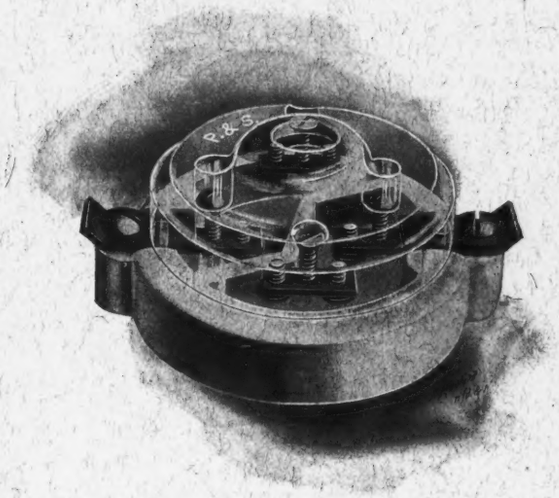

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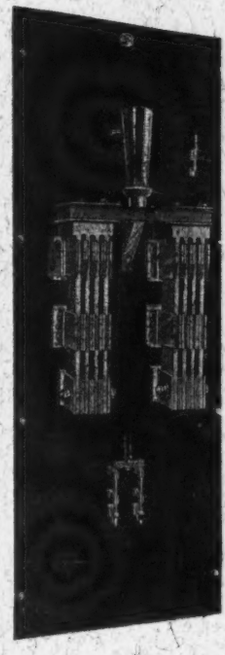

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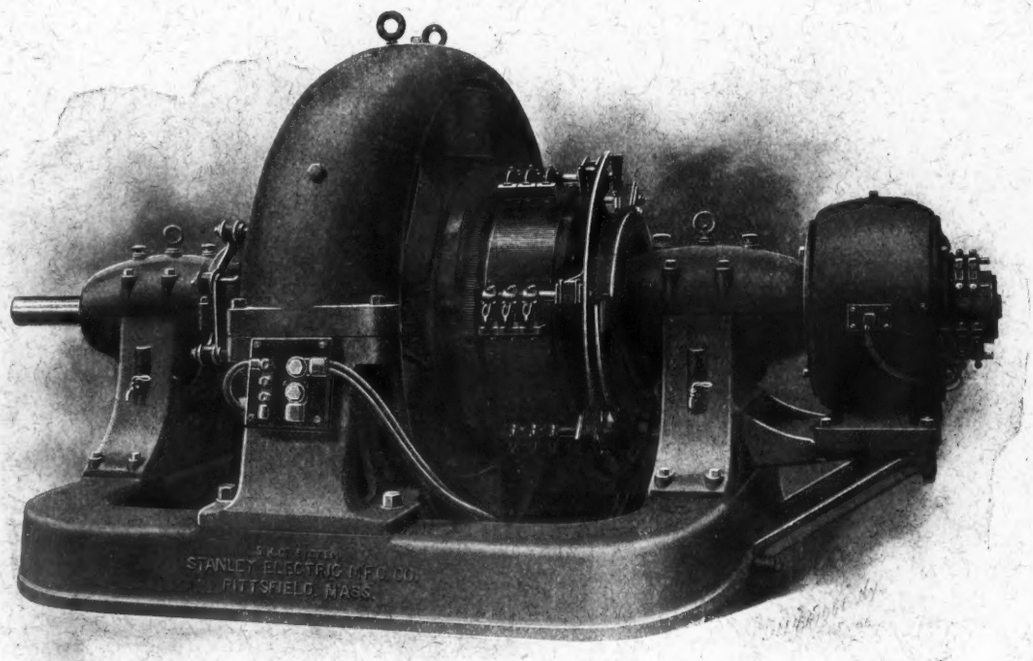

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